Source book for the inland fishery resources of Africa

Vol. 1

CIFA
TECHNICAL
PAPER
18/1

FOOD
AND
AGRICULTURE
ORGANIZATION
OF THE
UNITED NATIONS

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Vol. 1

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TECHNICAL
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18/1

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FOOD
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PREPARATION OF THIS DOCUMENT

The Source Book evolved from two earlier CIFA publications: "The Inland Waters of Africa" (1972), and "The Inland Fisheries of Africa" (1979), both by Dr. R.L. Welcomme. Dr. Garry Bernacsek, in the capacity of a consultant to FAO during the early 1980's, fused the two original publications, checked water bodies against large-scale maps, added tables on national catch and country characteristics from the FAO Yearbook of Fishery Statistics and generated potential yield estimates based on models similar to those developed by Henderson and Welcomme (1974). The Source Book reached a first draft stage in 1987.

In 1989 Mr. J-P. Vanden Bossche was hired as an FAO consultant to verify, edit, correct and update the earlier work, expand the coverage by combing the literature for information on new water bodies, add key references and maps of individual water bodies and countries and to compile a bibliography. This was completed in mid-1990.

Financing has come from a variety of sources. Much of the earlier work on SIFRA was funded by the Regular Programme of the FAO Inland Water Resources and Aquaculture Service. The Fisheries Policy and Planning Service also contributed. The bulk of the financing for the recent consultant work on updating and expanding, as well as printing and distribution, came from an FAO/Netherlands Regional Trust Fund Project, GCP/RAF/257/NET. The European Economic Community, through its activity "Ecology in Developing Countries", generously paid the costs of professional document preparation for the Source Book.

FAO welcomes comments on this publication. Any updates, corrections and additions also would be most sincerely appreciated. Correspondence should be directed to the Chief, Inland Water Resources and Aquaculture Service, FAO Fisheries Department, Rome, 00100 Italy.

Distribution:

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ABSTRACT

The Source Book for the Inland Fishery Resources of Africa (SIFRA) is a compendium, water body-by-water body, country-by-country, of information on inland fisheries and related topics.

The overall objective is to promote inland fisheries management and development by providing comprehensive information on Africa's inland fisheries in a uniform format, readily accessible to planners, policy makers and fishery workers.

The Source Book, presented in three books, is subdivided into 53 country and associated island files. The countries in Book 1 are: Angola, Botswana, Burundi, Central African Republic, Comoros, Congo, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Reunion, Rwanda, Seychelles, Swaziland, Tanzania, Uganda, Zaire, Zambia, and Zimbabwe.

Each country file is subdivided into seven sections: Geography and Climate, Hydrography, Fishery Production, Potential, State of the Fishery, Key Bibliography, Water Bodies Directory and Bibliography.

Under the Water Bodies Directory in each country file the water bodies are presented in alphabetical order under four basic categories: Lakes; Rivers, Floodplains and Swamps; Reservoirs; and Coastal Lagoons.

Inland water bodies are also divided into national waters, if they are located within one country, and international waters (indicated under the water body name in all country files), if they are located in two or more countries.

TABLE OF CONTENTS

SIFRA BOOK 1

Page

INTRODUCTION vii

COUNTRY PROFILES

Angola 1

Botswana 19
Burundi 29

Central African Republic 41
Comoros 49
Congo 51

Kenya 65

Lesotho 93

Madagascar 101
Malawi 119
Mauritius 135
Mozambique 141

Namibia 163

Reunion 169
Rwanda 173

Seychelles 197
Swaziland 199

Tanzania 209

Uganda 263

Zaire 303
Zambia 347
Zimbabwe 375

BIBLIOGRAPHY 395

INTRODUCTION

SIFRA BOOK 1

1. Purpose and justification

The Source Book for the Inland Fishery Resources of Africa (SIFRA) is a compendium, water body-by-water body, country-by-country, of information on physical characteristics, limnology and fisheries.

The overall objective is to promote inland fisheries management and development by providing comprehensive information on Africa's inland fisheries and fishery potential, in a uniform format, readily accessible to planners, policy makers and fishery workers.

At the national level SIFRA can serve as a basic reference for fishery workers and aquatic scientists on fisheries and limnology. With this baseline data in a simple format one can quickly discern where information is ample or lacking, in this way identifying and assessing needs for technical assistance for specific water bodies, or areas of a country.

More broadly, by taking a water body-by-water body approach, SIFRA illustrates the widespread importance of inland fisheries for economic, social and nutritional well-being. A major side benefit is to raise the awareness of planners and developers to the need for an ecological approach to the management and development of inland waters in order to conserve water resources for fisheries and aquaculture.

SIFRA has been designed to be useful at the regional level by taking into account shared water bodies and synthesizing information on them. Likewise, the same kinds of comparisons that are made at the national level can be made among countries to identify where needs are greatest and where cooperation on common problems is most likely to be successful.

2. Document organization

The Source Book, presented in three volumes, is subdivided into 53 country and associated island files. The countries and the distribution of inland waters in each volume are shown in Table 1 and Figure 1 of the Introduction. These divisions coincide well with the major river basins of Africa, shown in Figure 2.

Each country file is subdivided into seven sections:

1. Geography and climate
2. Hydrography
3. Fishery production/potential
4. State of the fishery
5. Key bibliography
6. Water bodies directory
7. Bibliography

Under Section 6 in each country file the water bodies are presented in alphabetical order under four basic categories:

- Lakes;
- Rivers, Floodplains and Swamps;
- Reservoirs; and
- Coastal Lagoons.

Inland water bodies are also divided into:
- national waters, if they are located within one country; and
- international waters (indicated under the water body name in all country files), if they are located in two or more countries.

Standard formats and parameter headings were used for each water body category to simplify data retrieval.

Individual country files are stored for easy updating by word processing. This will facilitate expansion of the files as new environmental and fishery data are received or new water bodies (e.g., reservoirs) are created.

3. Reliability of the data

The FAO fishery statistics (FISHDAB, published each year in the "FAO Yearbook, Fishery Statistics, Catches and Landings") were used as the main source in the table "FISH PRODUCTION AND PER CAPUT SUPPLY" in Section 3. Nominal catches from 1970 to 1987 were tabulated in each country file. These arise mainly from official national statistics, sometimes corrected by the FAO Fishery Statistics Service.

The figures for "Annual catch range" and "Potential annual yield" (Section 3) are based on specific water body fishery studies (as detailed in Section 6) and/or specific studies, all made by international experts. They were collected from published and unpublished field reports (FAO and other technical assistance organizations), from international publications, and from FAO colleagues' personal communications.

Sometimes the data from field observations are more reliable than the official data. However, as field observations were not available for all countries and water bodies, and as some estimates may vary from one author to another, they have been presented under the separate titles "Annual catch range" and "Potential annual yield". The variety of sources used explains why there are differences (sometimes even a large gap) between the "annual catch range" and the "nominal catches" for the same year. (It also explains the inevitable variations in the spelling of local geographical names.)

By referring to the sources cited, the reader can delve into the reliability of the data.

Besides presenting data on the physical and chemical characteristics of African water bodies and basic fishery statistics, one of the objectives of this publication was to present estimates of potential yields for each water body and country to facilitate assessments of the degree of exploitation of each country's fishery resources. The earlier version of the Source Book contained potential yield estimates based on models similar to those of Henderson and Welcomme (1974) and Welcomme (1976, 1985). However, with new data acquired as a result of updating and expanding the country files, these models are now outdated. An activity is presently underway to generate new models from which updated potential yield estimates will be calculated. In the meantime, the only potential yield estimates that are given in this version of the Source Book are those which can be cited.

Table 2 of the Introduction summarizes the statistics for the inland fisheries of the specific African countries reported in each of the three Source books. Official inland catches in 1987 are compared to the inland catch range and inland potential catch range, the latter two being the result of the most reliable field studies available.

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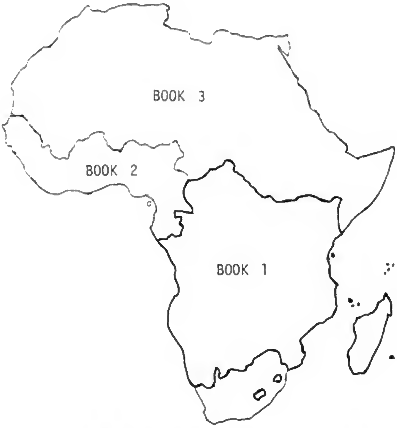

SIFRA					
BOOK 1		BOOK 2		BOOK 3	
Countries	Symbols	Countries	Symbols	Countries	Symbols
Angola	ANG	Benin	BEN	Algeria	ALG
Botswana	BOT	Burkina Faso	BKF	Chad	CHD
Burundi	BDI	Cameroon	CMR	Djibouti	DJI
Central African Republic	CAF	Cape Verde	CVI	Egypt	ECY
Comoros	COI	Côte d'Ivoire	IVC	Ethiopia	ETH
Congo	PRC	Equatorial Guinea	EQG	Libya	LIB
Kenya	KEN	Gabon	GAB	Mali	MLI
Lesotho	LES	Gambia	GAM	Mauritania	MAU
Madagascar	MAG	Ghana	CHA	Morocco	MOR
Malawi	MLW	Guinea	GUI	Niger	NER
Mauritius	MAR	Guinea-Bissau	GNS	Somalia	SOM
Mozambique	MOZ	Liberia	LIR	Sudan	SUD
Namibia	NAM	Nigeria	NIR	Tunisia	TUN
Reunion	REU	San Tome and Principe	STP	West Sahara	WSH
Rwanda	RWA	Senegal	SEN		
Seychelles	SEY	Sierra Leone	SIL		
Swaziland	SWA	Togo	TGO		
Tanzania	URT				
Uganda	UGA				
Zaire	ZAI				
Zambia	ZAM				
Zimbabwe	ZIM				

Figure 1 and Table 1
DISTRIBUTION OF COUNTRIES IN 3 SIFRA BOOKS

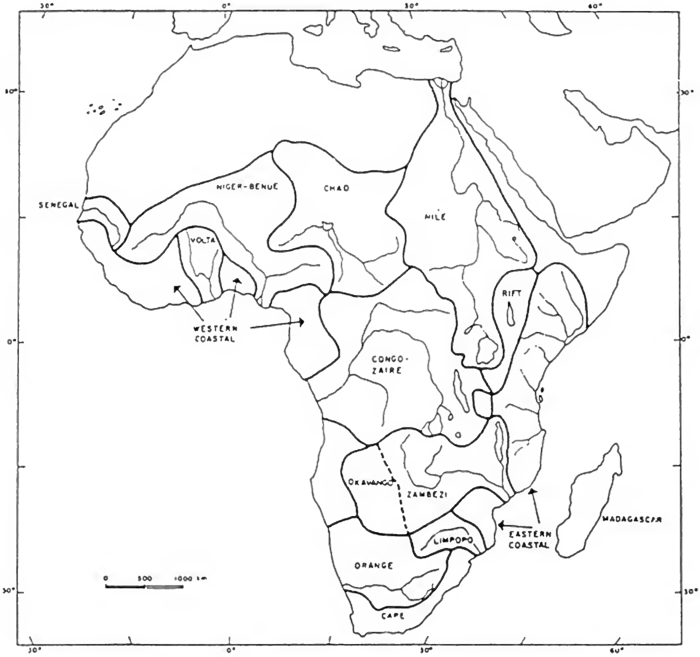

Figure 2. THE MAJOR RIVER BASINS OF THE AFRICAN CONTINENT
(Welcomme, 1972)

TABLE 2. SUMMARY STATISTICS FOR THE INLAND FISHERIES OF THE 53 AFRICAN COUNTRIES AND ASSOCIATED ISLANDS REPORTED IN SIFRA

Table 2a. 22 Countries reported in Book 1

	Catches 1987				Consumption 1987 1/		Degree of Exploitation	
Country	Total marine +inland +aquaculture (t) 1/	Inland (t) 1/	Inland aquacult. production (t)	Inland as % of total	Population '000	Per caput supply of inland fish (kg/person)	Inland catch range (t) 2/	Inland potential catch range (t) 2/
Angola	81 339	8 000	0	10	9 233	0.9	6 000-8 000	50 000-55 000
Botswana	1 900	1 900	0	100	1 192	1.6	1 200-1 750	8 000-15 000
Burundi	5 009	4 984	25	100	4 998	1.0	14 000-17 000	17 000-24 000
Central African Rep.	8 888	8 800	88	100	2 704	3.2	3 600-12 000	23 000-35 000
Comoros	5 250	0	0	0	472	0	0	0
Congo	31 013	13 385	115	43	1 837	7.4	11 000-16 000	70 000-100 000
Kenya	131 181	124 096	210	95	22 405	5.5	113 000	34 600-90 800
Lesotho	26	- 3/	26	100	1 601	0.02	10-30	290-870
Madagascar	63 589	45 806	194	72	10 610	4.3	40 000-45 000	77 000
Malawi	88 588	88 485	103	100	7 421	11.9	56 800-113 500	80 000-150 000
Mauritius	17 992	- 3/	40	0.2	1 085	0.04	- 3/	- 3/
Mozambique	36 117	246	21	0.7	14 733	0.02	246-5 000	55 000
Namibia	519 518	150	0	0.03	1 643	0.09	- 3/	- 3/
Reunion	1 543	0	22	1.4	547	0.04	- 3/	- 3/
Rwanda	1 630	1 565	65 4/	100	6 491	0.2	3 000-3 950	2 600-9 650
Seychelles	3 953	0	0	0	81	0	0	0
Swaziland	63	44	19	100	692	0.09	44-100	200-280
Tanzania	313 545	265 735	35	85	24 201	11.0	211 975-221 975	226 500-358 500
Uganda	200 038	200 000	38	100	16 595	12.0	95 500-214 000	141 290-147 530
Zaire	166 000	163 300	700	99	31 814	5.1	130 000-180 000	330 000-510 000
Zambia	68 000	66 980	1 020	100	7 139	9.5	66 500	117 300
Zimbabwe	17 500	17 344	156	100	9 433	1.8	13 613-20 831	22 000-26 000

1/ official statistics

2/ based on most reliable field reports

3/ no data available

4/ in 1986

COUNTRY FILES

SIFRA BOOK 1

ANGOLA

1. GEOGRAPHY AND CLIMATE (Welcomme, 1979a)

Angola (with a surface area of 1 246 700 km^2) is divided into

(a) Angola proper, which lies south of the Zaire River (6°-17° S and 12°-23° E); and
(b) Cabinda, a small enclave lying on the coast to the north of the Zaire River.

The major part of Angola is a central plateau, 1 000-1 600 m in altitude, rising in the west-central region to highlands of 2 000-2 500 m. There is a narrow coastal plain. The northern part of Angola is covered with rain forest; the south is savanna merging into semi-arid desert. Cabinda is low-lying, tropical and densely forested.

In general, the north of Angola is tropical in climate, whereas the south is semi-arid. The climate is largely conditioned by the cold Benguela current and gives a temperate character to the coastal regions. There are two main seasons: a cold, dry season from May to October; and a warm, wet season from November to April. During the cold period temperatures can drop to freezing on the plateau. Angola is a predominantly agricultural country with some mining in the northeastern region.

2. HYDROGRAPHY (Welcomme, 1979a)

2.1 Lakes

There are no large lakes in Angola, but there are numerous smaller bodies of water associated with the floodplains of river systems in the south and east of the country.

2.2 Rivers, Floodplains and Swamps

The country is, on the whole, well watered by rivers draining the central highland plateau. Poll (1967) assigns the rivers to five main basins corresponding to zoogeographical regions. These are:

(a) the Zaire River basin, where major tributaries include the Kasai and Kwango Rivers;
(b) the Zambezi River basin with the headwaters of the Zambezi and its tributaries and Lungue and Cuando Rivers, with some 20 000 km^2 of inundatable floodplain.
(c) the Okavango River basin, with the Cuito and Cubango Rivers;
(d) the northern coastal rivers, chief of which is the Cuanza River; and
(e) the Cunene River basin, including 15 000 km^2 of the Ovambo floodplain.

The major river channels total over 10 000 km in length, without counting small streams. Floodplains with numerous small lakes occur along the lower reaches of many of the rivers, discharging westward into the Atlantic Ocean.

2.3 Reservoirs

There are several impoundments; the largest are at Gove, on the Cunene, and Kiminha, on the Bengo. Several large reservoirs are projected for the future.

2.4 Coastal Lagoons

There are a few coastal lagoons; the largest are Buraco and Chissambe Lagoons.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

Several fish-culture stations already exist in the highlands. However, this sector has experienced a number of difficulties and drawbacks in the past, due mainly to the high cost of investment and inadequate training of personnel (Giudicelli *et al.*, 1987).

Vincke (1989, pers.comm.) estimates the aquaculture production as follows:

Species	1982	1983	1984	1985	1986	1987
Tilapia sparrmanii	0	7 t	-	2 t	0	0

3.2 Fish Production and per caput supply

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Angola, 1970-1987

		Nominal Domestic Production (t) 2/				Nominal Consumer Supply (kg/person) 2/			
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Marine capture	Total	Inland capture	Aqua-culture 3/	Marine capture	Total
1970	5 588	- 4/	-	368 200	368 200	-	-	-	-
1971	5 763	-	-	316 300	316 300	-	-	-	-
1972	5 944	-	-	599 100	599 100	-	-	-	-
1973	6 130	-	-	472 000	472 000	-	-	-	-
1974	6 322	-	-	393 259	393 259	-	-	-	-
1975	6 520	-	-	153 580	153 580	-	-	-	-
1976	6 753	-	-	74 542	74 542	-	-	-	-
1977	6 998	-	-	113 408	113 408	-	-	-	-
1978	7 247	-	-	118 630	118 630	-	-	-	-
1979	7 491	8 000 6/	-	106 072	114 072	1.0	-	-	-
1980	7 723	8 000	-	77 585	85 585	1.0	-	-	-
1981	7 939	8 000	-	123 457	131 457	1.0	-	-	-
1982	8 142	8 000	0 5/	103 988	111 988	1.0	0	-	-
1983	8 339	7 993	7 5/	102 876	110 876	1.0	0.0008	-	-
1984	8 540	8 000	-	64 700	72 700	0.9	-	-	-
1985	8 754	7 998	2 5/	66 497	74 497	0.9	0.0002	-	-
1986	8 990	8 000	0 5/	50 501	58 501	0.9	0	-	-
1987	9 233	8 000	0 5/	73 339	81 339	0.9	0	-	-

1/ Source: FAO

2/ Source: FAO Fisheries Dept., FISHDAB

Important note: Inland capture = excluding export. Marine capture = export statistics not available. It is therefore not possible to ascertain precisely what part of the marine capture is actually used for domestic consumption.

3/ included in "Inland capture" if not specified

4/ - = data not available

5/ Vincke, 1989 (pers.comm.)

6/ There are no official statistics for inland capture fisheries yield or aquaculture production, nor is it possible from other data sources to derive an accurate estimate of yield in any past year(s). The 8 000 t for 1979-1987 are rough estimates.

3.3 Inland catch range and potential yield

No detailed information available for:
Lakes Bezi-Bezi, Calundo, Cambala, Carumbo, Catete, Chibondo, Dilolo, Machive, Malanje, Muchova, Nuntechite, Uambafuca;
Rivers Bengo, Catumbela, Cuanza, Cubango, Cunene, Dande, Kasai, Longa, Zaire, Zambezi;
Floodplain Ovambo;
Reservoirs Cuando, Gove, Jamba, Kambumbe, Kiminha, Mabubas, Matala;
Lagoons Buraco, Carvalhao, Chissambe, Marembo.

Table 2. INLAND CATCH RANGE AND POTENTIAL YIELD

	Period	Annual catch range (t)	Potential annual yield (t) 1/
Moxico Province	current	2 500-5 000	20 000
Lower Zaire Basin	-	-	10 000
Coastal Basins (Bengo, Cuanza, Dande, Longa Rivers)	current	5 000	5 000-10 000
Cumido-Cubango Basin	-	-	5 000
Cunene Basin	-	-	5 000
Other Rivers, small lakes & Reservoirs	-	-	5 000

1/ Potential yield estimates after Matthes, 1982.

Total annual yield: 6 000 t (Giudicelli *et al.*, 1987)
8 000 t (see Table 1)
Potential annual yield: 50 000-55 000 t (Matthes, 1982)
113 000 t (SADCC, 1984)

4. STATE OF THE FISHERY

4.1 Yield

The lack of figures and reported catches from Angola almost certainly presents a false picture of the importance of inland fish and fisheries. There are four major areas for inland fisheries.

(a) Tributaries of the upper Zambezi River (Moxico Region). There are some 20 000 km^2 of floodplain with a potential yield of some 20 000 t/yr(*), as compared to an estimated current annual catch of 2 500-5 000 t.

(b) Ovambo floodplain (of the Cunene River). 15 000 km^2 of this international water lie in Angola and have a potential yield of circa 5 000 t(*). No current information is available about existing fishery.

(c) Floodplains of the coastal rivers (Dande, Bengo, Cuanga). The floodplain lakes alone have a combined surface area of circa 500 km^2. Total potential yield may be in the order of 5 000-10 000 t/yr(*). The current catch is estimated at circa 5 000 t/yr.

(d) Floodplain of the Cubango River (prior to discharge into the Okavango Swamp in Botswana). The potential yield is 5 000 t/yr(*). The current state of the fishery is unknown.

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*(Note: All potential yield estimates after Matthes, 1982)

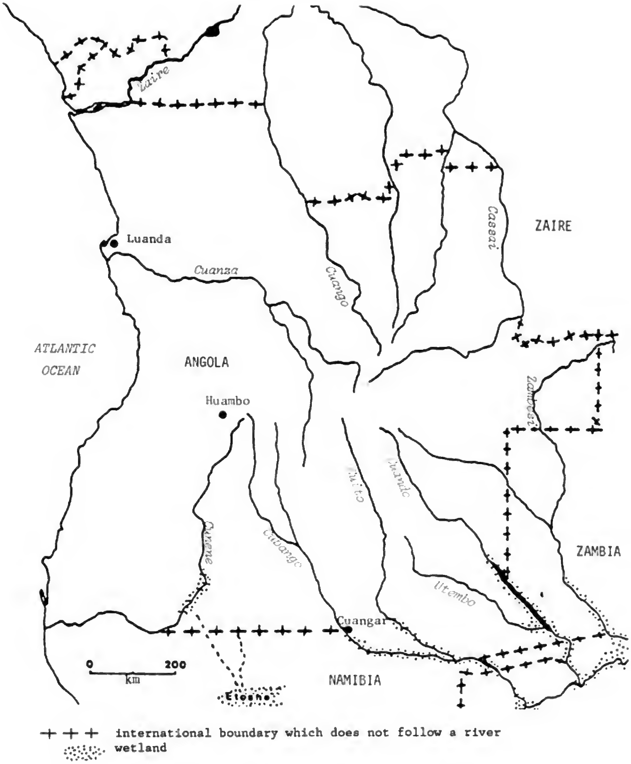

Fig. 1. WETLANDS OF ANGOLA
(Mepham, 1987)

As well as in these major areas, considerable potential for fisheries exists in the numerous other water bodies of Angola. An overall potential of 50-55 000 t/yr is calculated, with the present catch considerably less (possibly about 6-8 000 t/yr). Therefore there exists a great potential for increasing the catch.

4.2 Factors influencing yield

The continued unstable security situation, especially in the south, is probably the single greatest impediment to inland fisheries development. Inland fisheries also tend to be overshadowed by the highly productive marine fishery. Other factors cited as impairing development are lack of trained manpower, unavailability of fishing gear, and nearly total absence of adequate marketing, preservation and transport infrastructure. As most of the inland waters are rivers, the yield would be sensitive to any management works aimed at controlling flow (such as irrigation projects or dam constructions). Almost all major westward flowing rivers are now impounded near the upstream end of their coastal floodplains and this undoubtedly adversely affects floodplain yields to varying degrees. Furthermore, some of the rivers are in densely forested areas and are probably relatively unproductive.

4.3 Future development possibilities

The inland fishery sector is unimportant, relative to the extensive marine fishery, hence little attention has been paid to it. However, there is a large potential for development, particularly in the interior where marine fish rarely penetrate. Here, given the appropriate infrastructure and termination of security problems, there is likely to be rapid expansion of the sector.

5. KEY BIBLIOGRAPHY

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6. WATER BODIES DIRECTORY

Lakes

Bezi-Bezi
Calundo (Cameia)
Cambala
Carumbo
Catete
Chandumba
Chavuma Complex
Chiboco
Chibondo
Chicapa
Chicapa
Chiuoso
Cuango
Dilolo
Embundo Complex
Macanda
Machive
Magiuas
Malanje
Mangue
Maninga Complex
Muchova
Muongo
Nangage
Nuntechite
Sapua
Uambafuca

Rivers

Bengo
Catumbela
Cuanza
Cunene
Dande
Kasai/Kwa
Longa
Okavango/Cubango
Zaire/Congo
Zambezi

Floodplain

Ovambo

Reservoirs

Biopio
Cambambe
Cariango
Chissola
Cuando
Gove
Jamba
Kambumbe
Kiminha
Kuando
Kuene
Lamaun
Luachimo
Mabubas
Matala
Missombo
Tchamutete
Yamba-ia-oma

Lagoons

Buraco
Carvalhao
Chissambe (Massabi)
Ganga
Mabembo
Saca

LAKE BEZI-BEZI

Geographical data

Location: Angola - 16° 13'S; 19° 39'E
Surface area: 1.4 km^2
Max. length: 2 km
Max. width: 1 km

LAKE CALUNDO (= CAMEIA)

Geographical data

Location: Angola - 11° 43'S; 20° 48'E
Surface area: 4.2 km^2
Max. length: 4 km
Max. width: 1.5 km
Outflowing river: Lumeji

LAKE CAMBALA

Geographical data

Location: Angola - 9° 31'S; 13° 39'E
Surface area: 5.3 km^2
Max. length: 3 km
Max. width: 2.5 km

LAKE CARUMBO

Geographical data

Location: Angola - 7° 47'S; 19° 55'E
Surface area: 2.1 km^2
Max. length: 3 km
Max. width: 1 km
Inflowing river: Luchico
Outflowing river: Luchico

LAKE CATETE

Geographical data

Location:	Angola - 10° 30'S; 17° 45'E
Surface area:	5.6 km^2
Max. length:	4 km
Max. width:	2 km

LAKE CHANDUMBA

Geographical data

Location:	Angola - 10° 13'S; 19° 23'E
Outflowing river:	Chicundo

CHAVUMA LAKES COMPLEX

Geographical data

Location:	Angola - 15° 0'-15° 15'S; 21° 0'-22° 0'E
Outflowing river:	Chavuma
Special features:	a complex consisting of a large number of small lakes lying within the Chavuma River basin (the Chavuma discharges into the Zambezi River). The lakes include Lakes Banda, Licolocolo, Chavo, Suquia, Liesse, Capaco, Chitala, Lilepue, Massunzo, Nhate, Uito, Liamuia, Liassa, Libala, Luparala and Rianguelo.

LAKE CHIBOCO

Geographical data

Location:	Angola - 12° 55'S; 22° 37'E

LAKE CHIBONDO

Geographical data

Location:	Angola - 10° 32'S; 17° 48'E
Surface area:	9.0 km^2
Max. length:	4 km
Max. width:	3.2 km

LAKE CHICAPA

Geographical data

Location:	Angola - 10° 38'S; 19° 35'E
Outflowing river:	Cuilo

LAKE CHICAPA

Geographical data

Location:	Angola - 11° 10'S; 19° 12'E
Outflowing river:	Chicapa

LAKE CHIUOSO

Geographical data
Location: Angola - 12° 34'S; 22° 25'E
Inflowing river: Longonho
Outflowing river: Longonho

LAKE CUANGO

Geographical data
Location: Angola - 8° 33'S; 15° 41'E
Outflowing river: Munene

LAKE DILOLO

Geographical data
Location: Angola - 11° 31'S; 22° 03'E
Altitude: 1 097 m asl
Surface area: 18.9 km^2
Max. length: 9 km
Max. width: 3 km
Inflowing river: Calumbo
Outflowing river: Dilolo

Fisheries data
No. of fishermen: 300 in 1981

EMBUNDO LAKES COMPLEX

Geographical data
Location: Angola - 16° 10'S; 16° 50'E
Outflowing river: Chimomo
Special features: a complex of approximately ten small lakes, including Lakes Anruima and Kelly

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LAKE MACANDA

Geographical data
Location: Angola - 11° 47'S; 20° 49'E
Outflowing river: Lumeji

LAKE MACHIVE

Geographical data
Location: Angola - 16° 41'S; 20° 43'E
Surface area: 3.7 km^2
Max. length: 3.5 km
Max. width: 1.5 km

LAKE MAGIUAS

Geographical data
Location: Angola - 12° 56'S; 23° 21'E
Outflowing river: Lucunhe

LAKE MALANJE

Geographical data
Location: Angola - 9° 31'S; 16° 25'E
Surface area: 2.1 km^2
Max. length: 3 km
Max. width: 1 km
Outflowing river: Lombe

LAKE MANGUE

Geographical data
Location: Angola - 8° 50'S; 15° 47'E
Altitude: 1 204 m

MANINGA LAKES COMPLEX

Geographical data
Location: Angola - 12° 59'S; 24° 00'E
Outflowing river: Maninga
Special features: a group of small lakes drained by the Maninga River. Includes Lakes Cacunguana, Cambuata and Canengane.

LAKE MUCHOVA

Geographical data
Location: Angola - 16° 13'S; 19° 43'E
Surface area: 2.1 km^2
Max. length: 3 km
Max. width: 1 km
Outflowing river: Luangundo

LAKE MUONGO

Geographical data
Location: Angola - 10° 44'S; 19° 45'E

LAKE NANGAGE

Geographical data
Location: Angola - 10° 28'S; 19° 23'E

LAKE NUNTECHITE

Geographical data
Location: Angola - 15° 7'S; 13° 25'E
Surface area: 6.3 km^2
Max. length: 4.5 km
Max. width: 2 km
Outflowing river: Chibia

LAKE SAPUA

Geographical data
Location: Angola - 12° 53'S; 19° 20'E
Outflowing river: Luembe

LAKE UAMBAFUCA

Geographical data
Location: Angola - 17° 15'S; 20° 27'E
Surface area: 1.4 km^2
Max. length: 2 km
Max. width: 1 km

BENGO RIVER

Geographical data
Source: northern Angola (Crystal Mountains)
Altitude: 1 400 m asl
Total length: 300 km
Drainage area: 7 370 km^2
Countries traversed: Angola
Discharges to: Atlantic Ocean - 8° 44'S; 13° 24'E
Volume of discharge: 1.194 km^3/yr (47 m^3/sec, mean)
Special features: the lower 90 km has a lateral floodplain with numerous small lakes. These include Lakes Panguila (1.5 km^2), Quilunda (2.0 km^2) and Lalama (16 km^2) with a combined overall lacustrine surface area of 75.18 km^2). There is a dam at Kiminha.

Fisheries data
No. of fishermen: 85 in 1983
Potential annual yield: Coastal basins, including Dande, Bengo, Cuanza and Longa Rivers: 5 000 t (Matthes, 1982)

CATUMBELA RIVER

Geographical data
Source: Central Angola (Bie Plateau)
Altitude: 2 500 m asl
Total length: 260 km
Countries traversed: Angola
Discharges to: Atlantic Ocean - 12° 26'S; 13° 29'E
Special features: the Catumbela is impounded at Biopio and at Lamauna

Fisheries data
Potential annual yield: 200 t (excluding reservoirs)

CUANZA RIVER

Geographical data
Source: Central Angola (Bie Plateau)
Altitude: 1 590 m asl
Total length: 960 km
Drainage area: 121 470 km^2
Countries traversed: Angola
Major tributaries: Luando, Cutato, Cuquema
Discharges to: Atlantic Ocean - 9° 21'S; 13° 9'E, 60 km south of Luanda
Volume of discharge: 26.4 km^3/yr (58 m^3/sec, mean)
Special features: there is an extensive floodplain with numerous small lakes lying lateral to the main river channel along its last 160 km before the sea. These small lakes include Lakes Cassaque, Cabemba (21 km^2), Toa (10 km^2), Negolome, Cazanga, Quiombe and Muenga, with an overall combined lacustrine surface area of 184.13 km^2. There is an hydroelectric dam at Cambambe.

Fisheries data
No. of fishermen: 1 128 in 1983
Potential annual yield: Coastal basins, including Dande, Bengo, Cuanza and Longa Rivers: 5 000 t (Matthes, 1982)

CUNENE RIVER
(International water)

Geographical data
Source: central Angola (Bie Plateau)
Altitude: 1 800 m asl
Total length: 975 km
Drainage area: 83 000 km^2
Countries traversed: Angola, Namibia
Major tributaries: Calonga
Discharges to: Atlantic Ocean - 17° 15'S; 11° 46'E
Volume of discharge at mouth: 6.77 km^3
Special features: the Cunene is impounded at Matala, Kuene and Gove and on the Calonga tributary north of Cassinga. Some 15 000 km^2 of the Ovambo floodplain are situated within Angola.

Fisheries data
Potential annual yield: Cunene basin: 5 000 t (Matthes, 1982)

DANDE RIVER

Geographical data
Source: northern Angola (Crystal Mountains)
Altitude: 1 350 m asl
Total length: 285 km
Countries traversed: Angola
Discharges to: Atlantic Ocean - 8° 28'S; 13° 23'E
Volume of discharge at mouth: 50 m^3/sec (mean)
Special features: the lower 30 km has a lateral floodplain with numerous small lakes (including Lakes Sungue, Ibendua and Morima) with a combined surface area of 70.79 km^2. Further upstream there is a dam at Mabubas.

DANDE RIVER (cont.)

Fisheries data
No. of fishermen: 238 in 1983
Potential annual yield: Coastal basins, including Dande, Bengo, Cuanza and Longa Rivers: 5 000 t (Matthes, 1982)

KASAI/KWA RIVER
(International water)

Geographical data
Source: near Villa Luso, Angola (Kasai)
Altitude: 1 500 m
Total length: 1 735 km (last 85 km, from Kasai-Lukenie/Fimi confluence to Congo/Zaire confluence, called Kwa)
Countries traversed: Angola, Zaire
Major tributaries:

Lubilash/Sankuru	1 150 km
Kwango	750 km
Kwilu	960 km
Lukenie/Fimi	1 060 km

Discharges to: Congo/Zaire River at Kwamouth
Special features: Lake Maji Ndombe discharges into Congo/Zaire through the Fimi and Kwa Rivers. In Angola, one tributary (the Luachino River) is impounded by a small 8-m-high dam.

LONGA RIVER

Geographical data
Source: Angola, near Calilíueke
Altitude: 1 725 m asl
Countries traversed: Angola
Major tributaries: Nhia, Mugige
Discharges to: Atlantic Ocean - 10° 15'S; 13° 30'E
Special features: lateral floodplain along lowermost course (65 km long) with several small lakes (including Lakes Hengue and Toto). Source of Nhia tributary is a small lake.

Fisheries data
Potential annual yield: Coastal basins, including Dande, Bengo, Cuanza and Longa Rivers: 5 000 t (Matthes, 1982)

OKAVANGO/CUBANGO RIVER
(International water)

Geographical data
Source: Bie Plateau, Angola
Total length: 2 560 km
Countries traversed: Angola, Botswana, Namibia
Major tributaries: Cuito
Discharges to: the mouth of the Okavango splits into three main arms to form an internal delta which discharges into the Okavango Swamps. A further branch, the Thamalkane River, is connected to Lake Dow. A reversible and periodic connection exists between the Okavango and the Kwando and Zambezi system. During the floods the Okavango sends surplus water to the Kwando (or Chobe) River which, in turn, joins the Zambezi. If the Zambezi floods arise early, however, the process may be reversed.

OKAVANGO/CUBANGO RIVER (cont.)
Geographical data (cont.)
Volume of discharge at mouth: 254 m^3/sec

Fisheries data
Potential annual yield: Cumido-Cubango basin: 5 000 t (Matthes, 1982)

ZAIRE/CONGO RIVER
(International water)

Geographical data
Total length: 4 700 km
Drainage area: 4 014 500 km^2
Countries traversed: the basin covers parts of Angola, Burundi, Cameroon, Central African Republic, Congo, Rwanda, Tanzania, Zaire and Zambia. The lowermost 60 km of the river above the mouth forms the international boundary between Angola and Zaire. For a more detailed description of the Zaire/Congo basin, see the Zaire country file.
Discharges to: South Atlantic - 6° S; 12° E
Volume of discharge at mouth: 22-67 000 (mean 39 160) m^3/sec
Suspended silt load: 50 500 000 t/yr
Flood regime: bimodal floods with peaks in May and December

Physical and chemical data
both pH and conductivity vary considerably in the different water courses of the system. pH may be as low as 4.4 in flooded forests.
pH: upper course: 5.5; middle course: 6.5;
Tshwapa River: 4.0-6.5; at Yangambi: 7.05-7.8
Ionic composition: (Meybeck, 1978)

	mg/l
Na	1.70
K	1.10
Ca	2.40
Mg	1.25
Cl	2.85
SO_4	2.95
SiO_2	9.80
HCO_3	11.2

Fisheries data
Potential annual yield: Lower Zaire Basin in Angola: 10 000 t (Matthes, 1982)

ZAMBEZI RIVER
(International water)

Geographical data
Source: northwest Zambia and eastern Angola
Altitude: 1 600 m
Total length: 2 574 km
Drainage area: 1 300 000 km^2 total
Countries traversed: Angola, Mozambique, Zambia, Botswana, Namibia, Zimbabwe
Major tributaries: Cuando, Kafue, Luangwa, Shire. The Zambezi system also communicates with the Okovango system via the Chobe River.

ZAMBEZI RIVER (cont.)

Geographical data (cont.)
Discharges to: Indian Ocean - 18° 47'S; 36° E
Volume of discharge at mouth: 7 070 m^3/sec
Flood regime: December to July, maximum in March
Special features: in Angola, an extensive floodplain complex (20 000 km^2) with numerous small lakes within the Luena and Chefumage tributary basins.

Physical and chemical data (Coche, 1968)

		Above Lake Kariba	
		Flood	Low water
Temperature:		30° C	17° C
Conductivity:		K_{20} 50 µS/cm	96 µS/cm
pH:		-	7.4
Total alkalinity:		20 mg/l	44 mg/l
Total hardness:		17.9 mg/l	38.1 mg/l
Ionic composition:		mg/l	mg/l
	Na	1.70	3.26
	K	-	0.88
	Ca	4.93	-
	Mg	1.47	3.86
	NO_2-N	0.00376	0.00024
	NO_3-N	0.0047	0.0158
	PO_4-P	0.0295	0.0078

Fisheries data
No. of fish species: Upper Zambezi: 49 (Jubb, 1961)

OVAMBO FLOODPLAIN
(International water)

Geographical data
Location: Angola, Namibia - 16° -18° S; 14° 50'-16° E
Surface area: 23 000 km^2 (15 000 km^2 in Angola; 8 000 km^2 in Namibia)
Major inflowing river: Cunene
Outflowing river: overspill and seepage to Etosha Pan

BIOPIO RESERVOIR

Geographical data
Location: Angola - 12° 28'S; 13° 45'E
Dam height: 13 m
Major inflowing river: Catumbela
Outflowing river: Catumbela

CAMBAMBE RESERVOIR

Geographical data
Location: Angola - 9° 45'S; 14° 30'E
Dam height: 87.5 m
Major inflowing river: Cuanza
Outflowing river: Cuanza

CARIANGO RESERVOIR

Geographical data
Location: Angola

CHISSOLA RESERVOIR

Geographical data
Location: Angola

CUANDO RESERVOIR

Geographical data
Location: Angola - 12° 48'S; 15° 54'E
Surface area: 4.2 km^2
Max. length: 6 km
Max. width: 1 km

GOVE RESERVOIR

Geographical data
Location: Angola - 13° 26'S; 15° 52'E
Dam height: 58 m
Surface area: 140 km^2
Depth: 17.4 m (mean)
Volume: 2.436 km^3
Major inflowing river: Cunene
Outflowing river: Cunene

JAMBA RESERVOIR

Geographical data
Location: Angola - 14° 41'S; 16° 1'E
Surface area: 15 km^2
Overall length: 21 km
Max. width: 1 km
Major inflowing rivers: Colui, Cuandeja
Outflowing river: Colui

KAMBUMBE RESERVOIR

Geographical data
Location: Angola
Surface area: 0.20 km^2

KIMINHA RESERVOIR

Geographical data
Location: Angola - 8° 54'S; 14° 12'E
Dam height: 42 m
Surface area: 50 km^2
Depth: 28 m (mean)
Volume: 1.4 km^3
Major inflowing river: Bengo
Outflowing river: Bengo

Fisheries data
No. of fishermen: 535 in 1983

KUANDO RESERVOIR

Geographical data
Location: Angola

KUENE RESERVOIR

Geographical data
Location: Angola
Major inflowing river: Cunene
Outflowing river: Cunene

LAMAUN RESERVOIR

Geographical data
Location: Angola
Dam height: 15 m
Major inflowing river: Catumbela
Outflowing river: Catumbela

LUACHIMO RESERVOIR

Geographical data
Location: Angola - 7° 23'S; 20° 50'E
Dam height: 8 m
Major inflowing river: Luachimo
Outflowing river: Luachimo

MABUBAS RESERVOIR

Geographical data
Location: Angola - 8° 32'S; 13° 43'E
Dam height: 40 m
Surface area: 20 km^2
Depth: 2.7 m (mean)
Volume: 53×10^6 m^3
Max. length: 7 km
Max. width: 2 km
Major inflowing river: Dande
Outflowing river: Dande

MATALA RESERVOIR

Geographical data
Location: Angola - 14° 43'S; 15° 3'E
Dam height: 20 m
Surface area: 28 km^2
Depth: 2.5 m (mean)
Volume: 70×10^6 m^3
Max. length: 16 km
Max. width: 2.5 km
Major inflowing river: Cunene
Outflowing river: Cunene

MISSOMBO RESERVOIR

Geographical data
Location: Angola
Outflowing river: Kuebe

TCHAMUTETE RESERVOIR

Geographical data
Location: Angola
Outflowing river: Kalonga

YAMBA-IA-OMA RESERVOIR

Geographical data
Location: Angola

BURACO LAGOON

Geographical data
Location: Angola - 9° 0'S; 13° 3'E
Surface area: 95 km^2
Max. length: 27 km
Max. width: 5 km
Outflow: inlet to Atlantic Ocean

CARVALHAO LAGOON

Geographical data
Location: Angola - 15° 45'S; 12° 06'E
Surface area: 3.2 km^2
Max. length: 3 km
Max. width: 1.5 km
Major inflowing river: Hiquia
Outflow: to estuary of Curoca River

CHISSAMBE (= MASSABI) LAGOON

Geographical data
Location: Angola - 5° 03'S; 12° 04'E
Surface area: 35 km^2
Max. length: 12.5 km
Max. width: 4 km
Major inflowing river: Lubinda
Outflow: canal to Atlantic Ocean

GANGA LAGOON

Geographical data
Location: Angola - 7° 49'S; 13° 8'E
Major inflowing river: Loge

MABEMBO LAGOON

Geographical data
Location: Angola - 5° 10'S; 12° 13'E
Surface area: 14.9 km^2
Max. length: 8.5 km
Max. width: 2.5 km
Major inflowing river: Chiluango

SACA LAGOON

Geographical data
Location: Angola - 7° 10'S; 12° 54'E
Major inflowing river: Mebridege

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BOTSWANA

1. GEOGRAPHY AND CLIMATE (Welcomme, 1979a)

Botswana (with a surface area of 585 370 km^2) is a vast tableland of 1 000 m mean altitude, but in the north and northwest several depressions are associated with the drainage patterns of the main rivers. The country is generally arid savanna, grading into the Kalahari Desert to the west. The Okavango Depression in the northwest is somewhat better wooded and is generally more moist.

Most of the country is dry with hot summers and cold winters; in the desert regions winter temperatures (May-August) can fall below zero at night. Late summer (February-April) is the wettest time of the year, but there is much variability from year to year. Flooding of the Okavango depends greatly on the rainfall in the upper catchment in Angola which may be very different from that in Botswana. Most of the water in the Okavango Delta is lost by evaporation.

The Okavango Delta area is used for subsistence farming, either as dry agriculture or floodplain agriculture. Much of the basin is still occupied by wildlife as population densities are very low. At present there are no irrigation schemes, although some are being proposed.

2. HYDROGRAPHY

2.1 Lakes (after West, 1986)

The main natural lakes of importance are the Ngami, Xau and Liambezi. The Ngami and Xau Lakes form the terminal sumps of the Okavango Delta and are fed mainly by the Boteti River, while the Liambezi Lake is fed by the Chobe River. All three of these lakes used to be highly productive, supporting good fisheries, but in recent years, owing to continued drought, they have all dried up completely.

Until it dried up in 1982, Lake Ngami was a very productive lake which supported a rapidly developing fishery yielding over 200 t/yr. According to estimates, this lake has a potential of producing more than 3 000 tons of fish a year.

Lake Liambezi did not dry up completely until 1986. Before then, the lake used to support a sizeable fishery which was rapidly developing under a viable cooperative system. Yields as high as 1 000 t/yr have been obtained from this lake, most of which were exported. Available records show that up to 800 tons of fish per year (mainly iced) were marketed out of Lake Liambezi to Zimbabwe and Zambia in past years.

2.2 Rivers, Floodplains and Swamps (after Welcomme, 1979a)

The Okavango and its terminal swamps are the largest aquatic system in the country. The Okavango River enters Botswana from Angola after crossing the Caprivi strip, and almost immediately spreads out into fan-shaped delta swamp. The swamp is endorheic and only has outflow in exceptional years when part of the flow drains into the Zambezi system by way of the Selinda Spillway and the Linyati River, and into the Mababe Depression by way of the Khwai River. The Mababe Depression may also be flooded from the Zambezi River via the Savuti River. Some water also moves down the Boteti River toward the Makgadikgadi Depression, although this has not flooded in recent years. The Limpopo River forms part of the boundary with South Africa. Botswanian territory covers a minute part (4 km) of the Upper Zambezi River channel.

2.3 Reservoirs (after West, 1986)

Apart from the three natural lakes mentioned above, three dams have been constructed in Botswana. These are the Shashe Dam on the Shashe River, the Mopipi Dam on the Lower Boteti River and the Gaborone Dam on the Notswane River. These dams, which were constructed mainly for irrigation and cattle watering purposes, now support some fishing, being close to good marketing outlets at Francistown and Gaborone.

The potential yield from Shashe Dam is estimated at over 50 t/yr; that of Mopipi Dam at over 100 t/yr; and Gaborone Dam at 17 t/yr. However, there is very little fishing being carried out on these man-made water bodies at present.

2.4 Coastal Lagoons

None; Botswana is landlocked.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

There is no aquaculture in Botswana (Vincke, 1989, pers.comm.)

3.2 Fish Production and per caput supply

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Botswana, 1970-1987

Year	Population '000 1/	Nominal Domestic Production (excluding exports) (t) 2/			Nominal Consumer Supply (exluding imports and exports (kg/person)		
		Inland capture	No aqua-culture	Total	Inland capture	No aqua-culture	Total
1970	623	800		800	1.3		1.3
1971	647	1 100		1 100	1.7		1.7
1972	673	1 200		1 200	1.8		1.8
1973	699	1 200		1 200	1.7		1.7
1974	727	1 200		1 200	1.6		1.6
1975	755	1 200		1 200	1.6		1.6
1976	785	1 600		1 600	2.0		2.0
1977	815	1 500		1 500	1.8		1.8
1978	847	1 000		1 000	1.2		1.2
1979	880	1 000		1 000	1.1		1.1
1980	915	1 250		1 250	1.4		1.4
1981	951	1 450		1 450	1.5		1.5
1982	987	1 400		1 400	1.4		1.4
1983	1 026	1 250		1 250	1.2		1.2
1984	1 066	1 500		1 500	1.4		1.4
1985	1 107	1 500		1 500	1.3		1.3
1986	1 149	1 700		1 700	1.5		1.5
1987	1 192	1 900		1 900	1.6		1.6

1/ Source: FAO

2/ Source: FAO Fisheries Depart., FISHDAB

3.3 Inland catch range and potential yield

Table 2. INLAND CATCH RANGE AND POTENTIAL YIELD

	Period	Annual catch range (t) 1/	Potential annual yield (t) 1/
Lake Ngami	1977-81	800-300 2/	1 000-3 000 2/
Limpopo River	-	-	-
Zambezi River	-	-	-
Okavango Swamp	1977	400 2/	8 000 2/
Gaborone Reservoir	-	-	17
Lake Liamberi	1980's	180 2/	250 2/
Lake Xau	-	-	100
Mopipi Reservoir	-	-	
Lower Boteti River	-	-	
Sheshe Reservoir	-	-	50

1/ Sources: see text

2/ Catch and potential yield depend on drought situation

Total Annual Yield:	(depending on drought situation) 1 200-1 750 t (average about 1 600 t) (West, 1986)
Potential Annual Yield:	(depending on drought situation) 8 000-10 000 t (NORAD, 1987) 10 000-15 000 t (West, 1986)

4. STATE OF THE FISHERY (after West, 1986)

4.1 Yield

Botswana has two large and important national waterways: the Okavango Delta and the Chobe River system. These, together with their associated rivers and lakes mentioned in Section 2, constitute the main fishing grounds and are said to have considerable fishery resources which could contribute much more to the country's food supply and general economic well-being than they do at present. According to recent estimates these waters have a potential to yield some 10-15 000 tons of fish annually. However, these resources are unevenly distributed and do not coincide with the densely populated areas of the country. In fact, the main water bodies mentioned above are concentrated in the northern sector of the country, which is relatively sparsely populated compared to the more densely populated eastern and southern areas.

4.2 Factors influencing yield

The high potential yield (10-15 000 t) can be depressed considerably by poor hydrological conditions.

The Okavango Delta is tsetse infested and has dense growths of vegetation which render the area unattractive to human habitation. It constitutes the bird sanctuary and game reserve. Compared to other African floodplains, the Okavango has low productivity.

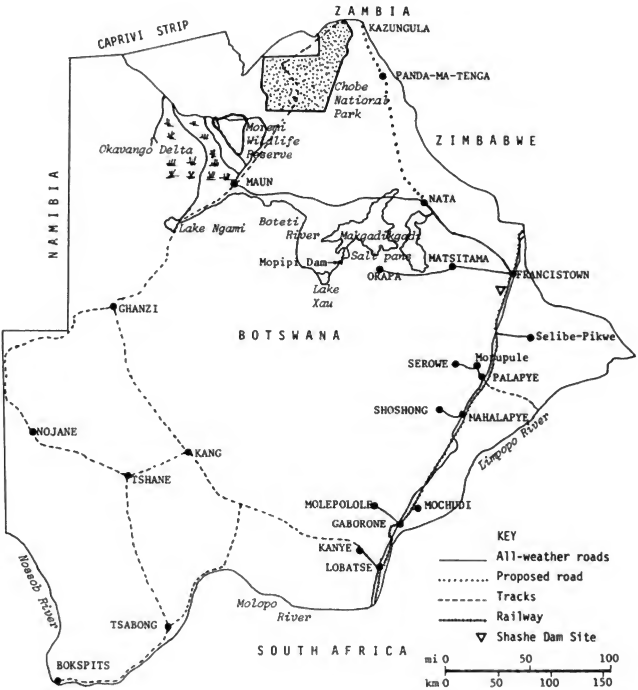

Fig. 1. MAP OF BOTSWANA

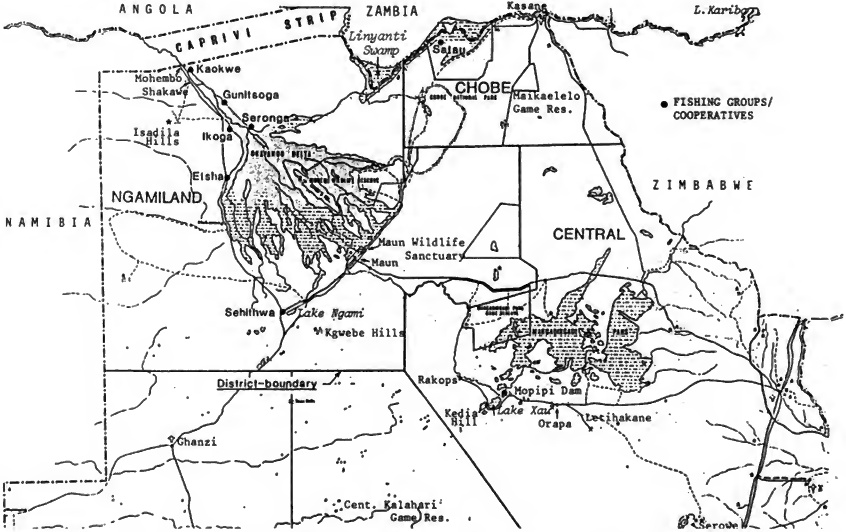

Fig. 2. LAKES, SWAMPS AND RIVERS IN NORTHERN BOTSWANA (NORAD, 1985)

4.3 Future development possibilities

Despite the high potential yield figure quoted above, the present production of 1 200-1 750 t/yr (annual average about 1 600 t) is small, thus leaving ample room for increasing both output and benefits from the resources.

Until fairly recently fishing was mainly at the subsistence level, by fishermen scattered in remote communities, mainly in the Okavango swamps and the Chobe districts, using rudimentary fishing gear and traditional wooden canoes called "Mokoros". The fishery has, however, progressed appreciably in the past two decades. Commercial fishing is now developing, not only on the lakes, but also on the main rivers (Boteti and Boro) and even in the remote areas of the Okavango.

5. KEY BIBLIOGRAPHY

NORAD, 1985

6. WATER BODIES DIRECTORY

Lakes		
Liamberi/Linyanti Swamp	Ngami	Xau

Rivers		
Limpopo	Okavango/Cubango	Zambezi

Floodplains/Swamps		
Okavango Swamp/Delta		

Reservoirs		
Gaborone	Mopipi	Shashe

LAKE LIAMBERI/LINYANTI SWAMP
(International water)

Geographical data (see Fig. 2)

Location:	Botswana, Namibia -18°S; 24°20'E
Surface area:	101 km^2 (non-drought periods) (NORAD, 1985). Surface area very variable depending on annual flood inflow volume in any particular year; may dry out. Very little of its surface area lies in Botswana.
Inflowing river:	Linyanti/Chobe
Outflowing river:	Linyanti/Chobe

Fisheries data

No. of fish species:	43 (NORAD, 1985)
Total annual catch:	-about 800 t in the 1960's and early 1970's, most of it marketed in Zambia and Zimbabwe; -no production in the late 1970's; -about 180 t in the early 1980's (NORAD, 1985)
Potential annual yield:	For 101 km^2 open water: 250 t (25 kg/ha/yr: NORAD, 1985)

LAKE NGAMI

Geographical data (see Fig. 2)
Location: Botswana - 20°28'S; 22°48'E
Surface area: very variable, depending on annual flood inflow volume in a particular year. Can reach about 200 km^2. Remained dry for many years prior to 1951 and was again dry in 1973-74 and in 1982 (1 km^2 at the end of 1982).
Depth: 1 m (mean, at max. level)
Max. length: 55 km
Max. width: 15 km
Outflowing river: Thamalakhane (tributary of Okavango/Cubango River)

Fisheries data
Total annual catch: 800 t in 1977;
300 t before lake dried out in 1982 (NORAD, 1985)
Potential annual yield: 1 000-3 000 t when full (NORAD, 1985)

LAKE XAU

Geographical data (see Fig. 2)
Location: Botswana - 21°20'S; 24°45'E
Surface area: small, non-permanent lake. Surface area depends on annual flood inflow volume in a particular year.
Inflowing/Outflowing river: Boteti

Fisheries data
Potential annual yield: 100 t - including Lake Xau, Mopipi Dam and Lower Boteti River (NORAD, 1985)

LIMPOPO RIVER
(International water)

Geographical data (Welcomme, 1972)
Source: Witwatersrand, South Africa
Altitude: 1 732 m
Total length: 1 680 km
Drainage area: 358 000 km^2 total (77 700 km^2 in Botswana)
Countries traversed: Botswana, Zimbabwe, Mozambique, South Africa
Major tributaries: Elefantes/Olifants, Nuanetsi, Umzingwani, Shashi, Changari
Discharges to: Indian Ocean - 25°12'S; 33°31'E
Volume of discharge at mouth: 5.33 km^3
Special features: numerous dams/reservoirs on tributaries, including Massingir (151 km^2) floodplain along lower course with numerous lakes. In Botswana the Limpopo is impounded at Gaborone.

OKAVANGO/CUBANGO RIVER
(International water)

Geographical data
Source: Bie Plateau, Angola
Total length: 2 560 km
Countries traversed: Angola, Botswana, Namibia

OKAVANGO/CUBANGO RIVER (cont.)

Geographical data (cont.)
Major tributaries: Cuito
Discharges to: The mouth of the Okavango splits into three main arms to form an internal delta which discharges into the Okavango Swamps. A further branch, the Thamalkane River, is connected to Lake Xau. A reversible and periodic connection exists between the Okavango and the Kwando and Zambezi system. During the floods the Okavango sends surplus water to the Kwando (or Chobe) River which, in turn, joins the Zambezi. If the Zambezi floods arise early, however, the process may be reversed.
Volume of discharge at mouth: 254 m^3/sec

ZAMBEZI RIVER
(International water)

Geographical data
Source: northwest Zambia and eastern Angola
Altitude: 1 600 m
Total length: 2 574 km (Botswana possesses only about 4 km of the south bank of the Upper Zambezi)
Drainage area: 1 300 000 km^2
Countries traversed: Angola, Mozambique, Zambia, Botswana, Namibia, Zimbabwe
Major tributaries: Cuando, Kafue, Luangwa, Shire. The Zambezi system also communicates with the Okavango system via the Chobe River.
Discharges to: Indian Ocean - 18°47'S; 36°E
Volume of discharge at mouth: 7 070 m^3/sec
Flood regime: December to July, maximum in March
Special features: Barotse floodplain, 700-9 000 km; Kafue flats, 200-7 000 km^2; Lukanga swamps, Kariba and Cahora Bassa dams/reservoirs, 3 000-8 000 km^2.

Physical and chemical data (Coche, 1968)

		Flood	Low water
Temperature:		30°C	17°C
Conductivity:		K_{20} 50 µS/cm	96 µS/cm
pH:		-	7.4
Total alkalinity:		20 mg/l	44 mg/l
Total hardness:		17.9 mg/l	38.1 mg/l
Ionic composition:			
		mg/l	mg/l
	Na	1.70	3.26
	K	-	0.88
	Ca	4 93	-
	Mg	1.47	3.86
	NO_2-N	0.00376	0.00024
	NO_3-N	0 0047	0.0158
	PO_4-P	0.0295	0.0078

Fisheries data
No. of fish species: Upper Zambezi: 49 (Jubb, 1961)

OKAVANGO SWAMP/DELTA

Geographical data
Location: northern Botswana - 18°20'-20°30'S; 21°40'-23°50'E
Area: up to 20 000 km^2 during flooding (May-August) (Welcomme, 1972)
10 000 km^2 mean area (NORAD, 1985)
Major inflowing river: Okavango/Cubango
Special features: landlocked basin with no outflow normally. Includes Lake Ngami.

Fisheries data
No. of fish species: 80; 50-60% tilapias (mainly *Oreochromis andersoni* and ex-*Tilapia melanopleura*); *Hydrocynus vittatus; Labeo lunatus*
No. of fishermen: 500 in 1984/85 (NORAD, 1985)
Total annual catch: 400 t in 1977 (excluding Lake Ngami)
500 t in 1984/85 (NORAD, 1985)
Potential annual yield: 8 000 t (NORAD, 1985)
Specific reference: Mepham, 1987b

GABORONE RESERVOIR

Geographical data
Location: Botswana
Surface area: 20.23 km^2 at USL
Major inflowing river: Limpopo
Outflowing river: Limpopo

Fisheries data
Potential annual yield: 17 t (West, 1986)

MOPIPI RESERVOIR

Geographical data
Location: Botswana
Major inflowing river: Lower Boteti River
Outflowing river: Lower Boteti River

Fisheries data
Potential annual yield: 100 t (West, 1986)

SHASHE RESERVOIR

Geographical data
Location: Botswana
Major inflowing river: Shashe
Outflowing river: Shashe

Fisheries data
Potential annual yield: 50 t (West, 1986)

7. BIBLIOGRAPHY

Coche, 1968
Jubb, 1961
Mepham, 1987b
NORAD, 1985; 1987
Welcomme, 1972; 1979a
West, 1986

BURUNDI

1. GEOGRAPHY AND CLIMATE (Welcomme, 1979a)

Burundi has a surface area of 27 830 km^2. Most of the country consists of grassy uplands and hills reaching an altitude of 2 600 m. The Ruzizi Valley and the very narrow shores surrounding Lake Tanganyika in the west are somewhat lower in altitude.

Although it is situated just south of the equator, the upland temperatures of Burundi are low because of its altitude. The Ruzizi Valley and the shores of Lake Tanganyika are somewhat warmer. There is a short dry season in January; major rains occur from February to May. The major dry season lasts from May to September, and is followed by a second rainy spell.

Burundi is occupied by pastoral peoples who have settled the hills. There is also intensive agriculture; coffee is the main cash crop. There is some irrigated agriculture within the Ruzizi Valley, which involves heavy applications of pesticides.

2. HYDROGRAPHY

2.1 Lakes (see Fig. 1)

The largest body of water in Burundi is the northeastern corner of Lake Tanganyika. About 2 600 km^2 of this lake lie within the boundaries of the country, representing about 8% of its total area. The lake is very deep and the shoreline plunges steeply downward. There are some small lakes (Upper Kagera* Lakes Complex) in the north of the country associated with the Akanyaru River. Largest of these are Lakes Cyohoha South and Rugwero, which are situated between Burundi and Rwanda. Three smaller lakes (Kazigiri, Lirwihindi and Kakamurindi) complete the series.

2.2 Rivers, Floodplains and Swamps (see Fig. 1)

There are no rivers in Burundi of major importance to fisheries. The Ruzizi River, which flows from Lake Kivu toward Lake Tanganyika, is relatively small and swift flowing. In the northern part of the country the tributaries of the Akanyaru River drain toward the Kagera in Rwanda and eventually Lake Victoria in Tanzania.

The main rivers are the Ruvubu (130 km in Burundi), the Kagera (border with Rwanda in the north), and the Malagarazi (border with Tanzania in the southeast), i.e., about 400 km in Burundi with a surface area of about 80 km^2 (Ministère de l'Agriculture et de l'Elevage/FAO, 1988).

There are a number of small floodplains and swamps in the north and southeast.

2.3 Reservoirs

There are three important reservoirs: Mugere (Province Bujumbura), Rwegura (Province Kayanza), and Ruhoha (Province Muyinga). Ruhoha Reservoir has been stocked with fish (Ministère de l'Agriculture et de l'Elevage/FAO, 1988).

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* Also called "Akagera"

2.4 Coastal Lagoons

None; Burundi is landlocked.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

The geography and the hydrological network are well suited to fish culture, although the water characteristics are rather poor (low pH: 5.5-6.5; low temperature; low conductivity: below 100 μS/cm). Aquaculture was introduced in the 1950's (about 352 ponds), but almost abandoned in the 1960's. A recent Peace Corps project (USAID 1985-87) rehabilitated rural aquaculture (425 ponds for 848 ares).

Fish species:
Oreochromis niloticus, *Tilapia rendalli*, *Oreochromis tanganicae*,
Clarias sp. (Min. Agric. et Elevage/FAO, 1988; Corsi *et al.*, 1986)

3.2 Fish production and per caput supply

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Burundi, 1970-1987

		Nominal Domestic Production (excluding exports) (t) 2/			Nominal Consumer Supply (exluding imports and exports (kg/person)		
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Total	Inland capture	Aqua-culture 3/	Total
1970	3 456	13 300	- 4/	13 300	3.8	-	3.8
1971	3 513	16 900	-	16 900	4.8	-	4.8
1972	3 570	7 500	-	7 500	2.1	-	2.1
1973	3 628	8 500	-	8 500	2.3	-	2.3
1974	3 687	10 982	-	10 982	2.9	-	2.9
1975	3 747	14 547	-	14 547	3.9	-	3.9
1976	3 815	20 333	-	20 333	5.3	-	5.3
1977	3 884	18 900	-	18 900	4.8	-	4.8
1978	3 955	15 682	-	15 682	3.9	-	3.9
1979	4 027	11 250	-	11 250	2.8	-	2.8
1980	4 100	14 767	-	14 767	3.6	-	3.6
1981	4 217	6 880	-	6 880	1.6	-	1.6
1982	4 338	8 131 5/	-	8 131	1.8	-	1.8
1983	4 462	6 359 5/	7 6/	6 366	1.4	0.001	1.4
1984	4 590	6 359 5/	2 6/	6 361	1.4	0.0004	1.4
1985	4 721	5 367 5/	2 6/	5 369	1.1	0.0004	1.1
1986	4 857	6 819 5/	21 6/	6 840	1.4	0.004	1.4
1987	4 998	4 984 5/	25 6/	5 009	1.0	0.005	1.0

1/ Source: FAO
2/ Source: FAO Fisheries Dept. FISHDAB, after Ministère de l'Agriculture et de l'Elevage, Burundi
3/ included in "Inland capture" if not specified
4/ - = data not available
5/ See also item 3.3 on page 32
6/ Vincke, 1989 (pers.comm.)

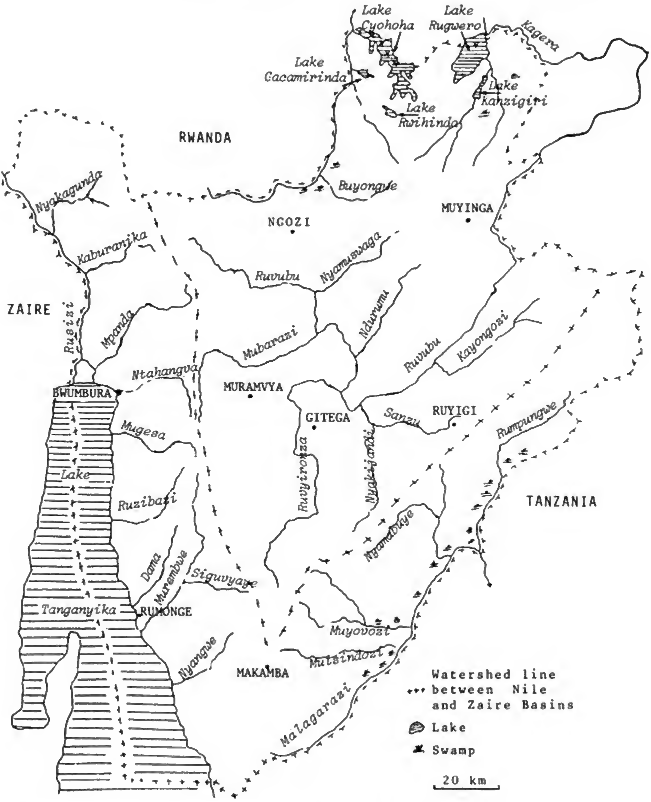

Fig. 1. HYDROGRAPHY OF BURUNDI
(adapted from: J. Gahama, 1983)

3.3 Inland catch range and potential yield

Table 2. INLAND CATCH RANGE AND POTENTIAL YIELD

Water body	Period	Annual catch range (t) 1/	Potential annual yield (t) 1/
Lake Cyohoha South	1986	50	200
Lakes Ingitamo, Kacamurinda, Kanzigiri, and Lirwihinda	-	-	100
Lake Rugwero (Rwero)	1986	350-400	320-360
Lake Tanganyika	1982-1988	13 600-16 000	16 000-23 000
Rivers Kagera, Malagarasi, Ruvubu, and Ruzizi	-	-	320
Total	1982-1988	14 000-16 450	16 940-23 980

1/ Sources: Corsi *et al.*, 1986; Mikkola & Lindquist, 1989; Min. Agric. Elevage/FAO, 1988.

Total annual yield: rounded, including estimation small lakes and rivers: 14 000-17 000 t

Note: This estimate, based on the latest FAO field reports, is about 2 to 3 times higher than the official "Ministère de l'Agriculture et de l'Elevage, Burundi" estimate, expressed under item 3.1 above.

Potential annual yield:

Lakes North (Kagera System)	700 t
Rivers	320 t
Lake Tanganyika:	16 000-23 000 t
Total Burundi (rounded)	17 000-24 000 t
Corsi *et al.*, 1986:	16 000-20 000 t

4. STATE OF THE FISHERY

4.1 Yield

Practically all of the fish caught in Burundi come from Lake Tanganyika. Only a small amount of fish for local consumption are taken from the lakes in the north of the country. There are three main types of fishery on Lake Tanganyika: a "traditional fishery" operated from dug-out canoes using hand nets, seine nets and gill nets; a "small scale fishery" operating from catamarans using lift nets; and an "industrial fishery" operating from larger vessels using purse seines. The two latter categories and, to some extent, the first, fish for 'Ndagala' with light attraction. The "traditional fishery" also uses beach seines for small cichlids. Mainstay of the fisheries is the 'Ndagala', which consists of two species: *Limnothrissa miodon, Stolothrissa tanganicae;* and the "Mukeke", *Luciolates stappersii.*

The FAO project for research into the lake fish stocks estimated that the mean sustainable yield from the lake fisheries would be about 17 000 t/yr; the present catch levels fluctuate around this level.

4.2 Factors influencing yield

The fishery in Lake Tanganyika concentrates on a stock of pelagic fish whose density probably depends on the concentrations elsewhere in the lake. At present Burundi (in the north) and Zambia (in the south) are the only areas of the lake where catches are approaching the maximum that can be predicted. By far the greater part of the lake is still exploited at a relatively low level. As exploitation increases generally, the Burundi catch may be affected.

The increase in the number of fishing units (catamarans and industrial vessels) in 1983 and 1984, together with the recent decrease of catches and the higher percentage of Ndagala caught, tends to show that the threshold to over-exploitation is close. Lake Cyohoha, with its poor plankton and fishing effort that does not pay (0.8 kg/day/fisherman), may also be at the maximum of its exploitation. Production in Lake Rugwero already reached the estimated potential yield.

4.3 Future development possibilities

As the Lake Tanganyika pelagic fishery is approaching maximum exploitation it is difficult to see that the production of freshwater fish in Burundi can be significantly increased. The northern lakes are small and seem already exploited at their maximum production. A study on Cyohoha Lake should be undertaken to evaluate fish stocks and actual yield potential. Higher fish supply in Burundi should be expected through the development of aquaculture.

5. KEY BIBLIOGRAPHY

Corsi *et al.*, 1986
Ministère de l'Agriculture et de l'Elevage/FAO, 1988.

6. WATER BODIES DIRECTORY

Lakes

Cyohoha
Ingitamo
Kacamurinda (Camirinda)
Kanzigiri
Lirwihinda (Rwihinda)
Rugwero
Rungazi
Tanganyika

Rivers

Kagera
Malagarasi
Ruvubu
Ruzizi

LAKE CYOHOHA
(International water)

Geographical data

Location: Rwanda, Burundi - 2° 20'-2° 35'S; 29° 58'-30° 13'E (Upper Kagera Lakes Complex)
Altitude: 1 380 m
Surface area: 76 km^2 (58 km^2 in Burundi) (Kiss, 1977a)
Depth: 11 m (mean: 5.2 m) (Kiss, 1977a)
Volume: 395×10^6 m^3

LAKE CYOHOHA (cont.)

Geographical data (cont.)
Max. length: 32 km
Max. width: 2 km (Kiss, 1977a)
Shoreline: 227 km total; 167 km in Burundi (Kiss, 1977a)
Note: Lake Cyohoha is called "Cyohoha South" in Rwanda

Physical and chemical data (Kiss, 1976a; 1977a)
Conductivity: K_{20} 250-256 µS/cm; 296 (surface); 319 (bottom) µS/cm
pH: 8.5-9.5 (surface); 7.2 (bottom)
Temperature: 23-27° C (surface)
Ionic composition:

	mg/l
Na	25.75
K	9.55
Ca	9.0
Mg	10.85
Cl	4.30
SiO_2	5.05
HCO_3	152-171 (surface-bottom)

Fisheries data
No. of fish species: 7 (3 *Oreochromis spp.*; 2 *Haplochromis spp.*; 1 *Synodontis sp.*; 1 *Clarias sp.*) (Kiss, 1977a)
No. of fishermen: 20 in Burundi (Kiss, 1977a)
50 in Burundi (100 in lake), part-time farmers/fishermen (Corsi *et al.*, 1986)
Total annual catch: 40 t in Burundi in 1975 (Kiss, 1977a)
50 t in Burundi (Corsi *et al.*, 1986)
Potential annual yield: 200 t; limited due to poor phyto- and zoo-plankton (Corsi *et al.*, 1986; Kiss, 1977a)

LAKE INGITAMO

Geographical data
Location: Burundi - 2° 30'S; 30° 01'E (Upper Kagera Lakes Complex)
Surface area: 0.7 km^2
Max. length: 1 km
Max. width: 1 km

Fisheries data
Potential annual yield: 5 t (Corsi *et al.*, 1986)

LAKE KACAMURINDA (= CAMIRINDA)

Geographical data
Location: Burundi - 2° 27'S; 30° 00'E (Upper Kagera Lakes Complex)
Surface area: 2.5 km^2
Max. length: 5 km
Max. width: 1.5 km

Fisheries data
Potential annual yield: 18 t (Corsi *et al.*, 1986)

LAKE KANZIGIRI

Geographical data

Location: Burundi - 2° 27'S; 30° 22'E (Upper Kagera Lakes Complex)

Surface area: 7.5 km^2

Max. length: 9.5 km

Max. width: 2 km

Fisheries data

Potential annual yield: 53 t (Corsi et al., 1986)

LAKE LIRWIHINDA (= RWIHINDA)

Geographical data

Location: Burundi - 2° 33'S; 30° 05'E (Upper Kagera Lakes Complex)

Surface area: 3.4 km^2

Max. length: 4 km

Max. width: 1.5 km

Fisheries data

Potential annual yield: 24 t (Corsi et al., 1986)

LAKE RUGWERO

(International water)

Geographical data (Kiss, 1977a)

Location: Rwanda, Burundi - 2° 21'-2° 27'S; 30° 17'-30° 24'E (Upper Kagera Lakes Complex)

Altitude: 1 350 m

Surface area: 100 km^2 (80 km^2 in Burundi)

Depth: 3.9 m (max); 2.1 m (mean)

Volume: 210 x 10^6 m^3

Max. length: 18 km

Max. width: 14.5 km

Shoreline: 76 km

Physical and chemical data (Kiss, 1977a)

Conductivity: K_{25} 156 μS/cm (surface); 158 μS/cm (bottom)

pH: 8.8 (surface); 7.5 (bottom)

Temperature: 21.7-26.2° C

Oxygen: saturation: 120-150% (surface); 70-90% (bottom)

Ionic composition:

	mg/l
Na	13.40
K	6.35
Ca	4.40
Mg	6.07
Cl	5.40
SiO_2	37.0
HCO_3-CO_3	91.51

Fisheries data

No. of fish species: 17 in 4 families (Cichlidae, Cyprinidae, Clariidae, Mochokidae)*

No. of fishermen: in Burundi: 45 in 1975/76*
in Lake: 150 in 1975/76*

Total annual catch: in Lake: 300 t in 1976*
350-400 t**

LAKE RUGWERO (cont.)

Fisheries data (cont.)

Potential annual yield:	in Burundi:	320-360 t**
	in Lake:	400-450 t**
	limited because of the lack of beaches for reproduction of cichlids, and former overfishing*	
Sources:	*	Kiss, 1977a
	**	Corsi *et al.*, 1986

LAKE RUNGAZI

Geographical data

Location:	Burundi - 2° 32'S; 30° 00'E (Upper Kagera Lakes Complex)
Surface area:	about 0.5 km^2

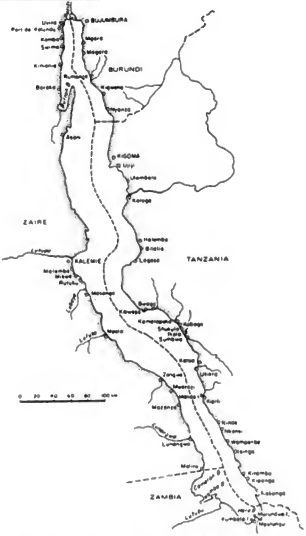

Fig. 2. LAKE TANGANYIKA
(Welcomme, 1972)

LAKE TANGANYIKA
(International water)

Geographical data (see Figs. 1 and 2)
Location: Burundi, Tanzania, Zaire, Zambia - 3° 20'-8° 50'S; 30° E;
Altitude: 773 m
Surface area:

Burundi	2 600 km^2	(8%)
Tanzania	13 500 km^2	(41%)
Zaire	14 800 km^2	(45%)
Zambia	2 000 km^2	(6%)
Total	32 900 km^2	

Depth: 1 435 m (max); 700 m (mean)
Volume: 18 940 km^3
Max. length: 673 km
Max. width: 48 km
Shoreline: 1 500 km total; 135 km in Burundi
Catchment area: 249 000 km^2
Major inflowing river: Malagarasi, Ruzizi
Outflowing river: Lukuga

Physical and chemical data
Conductivity: K_{20} 520-610 μS/cm
pH: 7.3-7.8
Surface temperature: 25° C
Oxygen: Oxygen limit: 80 m
Photosynthetic production: 0.8-1.1 $gC/m^2 \cdot day$ (Melack, 1976)
Ionic composition: (Talling & Talling, 1965)

	mg/l
Na	57.0
K	35.0
Ca	9.3
Mg	43.3
Cl	26.5
SO_4	5.0
SiO_2	0.38
HCO_3+CO_3	409.3

Fisheries data
No. of fish species: 214, of which 134 belong to the family Cichlidae (Greenwood, 1964)
Main catches:
Clupeidae: *Stolothrissa tanganicae* (Ndagala); *Limnothrissa miodon*
Centropomidae: *Lates spp.* (3 sp.); *Luciolates stappersi* (Mukeke)
No. of fishermen: in Burundi in 1988: estimated 6 000 (Mikkola & Lindquist, 1989)
No. of boats: in Burundi in 1988 (Mikkola & Lindquist, 1989):

industrial fishing units	17
artisanal fishing units	1 000
coastal canoe fishing units	50

Total annual catch and effort in Burundi waters:

Year	Total catch (t)	No.of boats
1952	2 500	-
1953	3 000	-
1954	4 100	-
1955	5 482	-
1956	4 492	-
1957	7 541	-
1958	10 010	-

LAKE TANGANYIKA (cont.)

Fisheries data (cont.)
Total annual catch and effort in Burundi waters: (cont.)

Year	Total catch (t)	No.of boats
1959	10 220	-
1960	7 820	1 532
1961	5 210	1 525
1962	7 100	1 522
1963	10 500	1 434
1964	9 556	1 479
1965	20 207	1 848
1966	16 695	1 832
1967	13 520	1 853
1968	12 289	1 855
1969	16 181	1 897
1970	13 291	1 989
1971	16 895	1 990
1972	8 854	1 634
1973	9 396	-
1974	12 124	-
1975	14 778	-
1976	20 320	-
1977	24 050	-
1978	14 860	-
1979	11 249	-
1982	13 600 (Corsi *et al.*, 1986)	
1988	16 000 (Mikkola & Lindquist, 1989)	

Total annual catch and effort in total Lake:

	1982 (Corsi et al., 1986)	1988 (Mikkola & Lindquist, 1989)
Burundi	13 600	16 000
Tanzania	25 000	25 000
Zaire	30 000	30 000
Zambia	10 500	14 000
Total	80 000	85 000

Potential annual yield:

	(Corsi et al., 1986) (t)	(Mikkola & Lindquist, 1989) (max. t)
Burundi	21 000	23 000
Tanzania	122 000	121 000
Zaire	135 000	133 000
Zambia	19 000	18 000
Total	300 000 (90 kg/ha)	295 000

KAGERA RIVER
(also called AKAGERA RIVER)
(International water)

Geographical data
Source: Burundi/Rwanda
Total length: 785 km
Countries traversed: Burundi, Rwanda, Tanzania, Uganda
Major tributaries: Akanyaru (Burundi, Rwanda), Nyabarongo (Rwanda)
Discharges to: Lake Victoria

KAGERA RIVER (cont.)

Geographical data (cont.)

Special features:

(1) Upper Kagera Lakes Complex: a group of lakes distributed as follows:
in Burundi: Ingitamo, Kacamurinda, Kanzigiri, Lirwihinda, Rungazi;
in Rwanda: Birira, Gaharwa, Gashanga, Kidogo, Kirimbi, Mirayi, Mugesera, Muhazi, Murago, Sake;
international waters (Burundi/Rwanda): Cyohoha South, Rugwero.

(2) Rusuma Falls: in Rwanda

(3) Lower Kagera Lakes Complex and Floodplain/Swamp: a group of lakes and adjacent floodplain/swamp. Lakes distributed as follows:
in Rwanda: Chuju, Hago, Ihema, Iwapibali, Kishanja, Kivumba, Mihindi, Muhari, Nasho, Ngerenke, Rukira, Rwakibare, Rwampanga, Rwanyaki Zinga, Rwehikama, Sekena;
in Tanzania: Bisongo, Kajumbura, Lwelo, Mujunju, Rushwa.
Floodplain/swamp area in Rwanda is circa 1 000 km^2.

Physical and chemical data (Kiss, 1977a)

Conductivity: K_{25} 111 μS/cm

pH: 7.01

Ionic composition:

	mg/l
Na	4.1
K	1.0
Ca	4.6
Mg	4.9
Cl	7.4
HCO_3-CO_3	42.7
Fe++	0.3

Fisheries data

Potential annual yield:
320 t in Burundi for all rivers:
estimate based on rivers water surface area of 80 km^2 (Min. de l'Agric. et de l'Elevage/FAO, 1988) and on a productivity of 40 kg/ha.

MALAGARASI RIVER

(International water)

Geographical data

Source: along Tanzania/Burundi frontier

Altitude: 1 859 m

Total length: 470 km (110 km along Tanzania/Burundi frontier); Ugalla tributary is 495 km

Drainage area: 131 572 km^2 (126 133 km^2 in Tanzania; 5 439 km^2 in Burundi)

Countries traversed: Tanzania, Burundi

Major tributaries: Ugalla, Luanga

Discharges to: Lake Tanganyika - 5° 13'S; 29° 49'E

Fisheries data

Potential annual yield:
All rivers in Burundi: 320 t:
estimate based on rivers water surface area of 80 km^2 (Min. de l'Agric. et de l'Elevage/ FAO, 1988) and on a productivity of 40 kg/ha.

RUVUBU RIVER

(International water)

Geographical data

Source: Burundi
Length: 130 km in Burundi
Countries traversed: Burundi, Tanzania
Discharges to: Kagera River

Fisheries data

Potential annual yield:
All rivers in Burundi: 320 t:
estimate based on rivers water surface area of 80 km^2 (Min. de l'Agric. et de l'Elevage/FAO, 1988) and on a productivity of 40 kg/ha.

RUZIZI RIVER

(International water)

Geographical data

Source: Lake Kivu
Countries traversed: Burundi, Rwanda, Zaire
Discharges to: Lake Tanganyika in Burundi

Physical and chemical data

Conductivity: upper course, K_{18} 1 190 μS/cm
lower course, K_{18} 828 μS/cm

Ionic composition:

	(Beauchamp, 1939) mg/l	(Dubois, 1958) mg/l
Na	94.8	98.0
K	63.0	74.0
Ca	8.4	8.5
Mg	67.0	101.6
Cl	23.8	16.6
SO_4	17.8	9.0
SiO_2	9.0-9.8	8.0
HCO_3+CO_3	638.1	585.6

Fisheries data

Potential annual yield:
All rivers in Burundi: 320 t:
estimate based on rivers water surface area of 80 km^2 (Min. de l'Agric. et de l'Elevage/FAO, 1988) and on a productivity of 40 kg/ha.

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CENTRAL AFRICAN REPUBLIC

1. GEOGRAPHY AND CLIMATE (Welcomme, 1979a)

Central African Republic has a surface area of 622 980 km^2. Essentially a well-watered plateau, the uplands (circa 1 500 m altitude) serve as a watershed dividing the Chari Basin from that of the Oubangui/Zaire. Most of the country is open savanna tending to become more arid toward the north. There is some rain forest in the extreme southwest and semi-desert in the northeast.

The climate is fairly consistent over most of the country with rains well dispersed throughout the year. There is, however, a drier period from December through April and a wetter period from May through October.

The Central African Republic has an entirely agricultural economy with a largely rural population, most of which is concentrated in the south of the country. There are large tracts of wild and uninhabited land.

2. HYDROGRAPHY (see Figure 1)

2.1 Lakes

There is one medium-sized lake in the North (Lake Mamoun). Small lakes are abundant on the floodplains of the larger rivers.

2.2 Rivers, Floodplains and Swamps (Welcomme, 1979a)

The Central African Republic is divided into two main watersheds:

To the south there is the Zaire Basin, where the Oubangui (together with its headstream, the Mbomou) forms the southern border of the country for over 1 000 km, and is fed by numerous small rivers. The Mambere drains into the Sangha River, which also feeds the Zaire River.

To the north two main blocks of rivers flow toward the Chari River. In the northeast there is the Bahr Aouk and in the northwest the Bamingui and Ouham.

Extensive floodplains (circa 30 000 km^2) are developed in both blocks.

2.3 Reservoirs

There are several small dams in the country, some (i.e. Boukoko and Baoro) reaching an area of several hectares.

2.4 Coastal Lagoons

There are no coastal lagoons; the country is landlocked.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture (Deceuninck, 1985; Vincke, 1989 pers.comm.)

Aquaculture was introduced in Central African Republic in 1952 and reached its maximum development in 1958 (12 000 to 20 000 ponds), before decreasing in the 1960's. Aquaculture rehabilitation started in 1968 with FAO/UNDP regional project, followed by other projects. In 1984, about 8 500 fishfarmers were exploiting some

Table 1. EVOLUTION OF AQUACULTURE, Central African Republic, 1974-1984 (after Deceuninck, 1985)

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
No. fishfarmers	167	698	1 272	1 634	1 974	3 275	4 313	6 483	6 882	8 500	8 500
No. ponds	273	910	1 533	2 086	2 588	4 236	6 600	7 845	8 500	10 000	10 000
No. ponds in activity	-	531	1 022	1 045	1 380	3 083	4 725	6 210	6 349	7 069	7 794
Surface area ponds, ares	440	1 596	2 159	3 014	3 815	5 368	8 580	9 277	9 848	13 600	16 300
Surface area ponds in activity, ares	-	1 083	1 351	1 452	2 205	3 474	6 409	8 231	7 576	9 613	12 704
Mean production, kg/are/yr	(12)	22.8	18.2	20.8	(20.8)	19.2	(12.5)	16 4	20	21.2	21.2
Estimation total production aquaculture (t)	(5)	24.7	24.6	30.2	45.8	66.7	(80)	103.6	150	203.8	269

10 000 ponds for a total area of 127 ha (see Table 1) (Deceuninck, 1985). Aquaculture production started decreasing again in 1985 (Vincke, 1989, pers.comm.). Aquaculture yield potential is estimated at 3 500 t/yr.

Main fish species raised:

- *Oreochromis niloticus* (190 t in 1986);
- *Clarias gariepinus* (*C.lazera*) (3 t in 1986);
- *Heterotis niloticus*.

Evolution of Rural Aquaculture, 1984-1988
(cited by Janssen, 1989)

	Dec. 1984	Sept. 1988
No. Fish Farmers	5 692	1 982
No. ponds in production	8 019	3 090

3.2 Fish Production and per caput Supply

Table 2. FISH PRODUCTION - Central African Republic, 1970-1987

		Nominal Domestic Production (excluding exports) (t)			Nominal Consumer Supply (exluding imports and exports (kg/person)		
Year	Population '000 1/	Inland capture 2/	Aqua-culture 3/	Total	Inland capture	Aqua-culture 3/	Total
1970	1 875	9 700	-	9 700	5.2	-	5.2
1971	1 910	9 040	-	9 040	4.7	-	4.7
1972	1 946	11 300	-	11 300	5.8	-	5.8
1973	1 982	11 300	-	11 300	5.7	-	5.7
1974	2 019	11 300	5 4/	11 300	5.7	0.002	5.6
1975	2 057	11 515	25 4/	11 540	5.6	0.01	5.6
1976	2 103	10 000	25 4/	10 025	4.7	0.01	4.7
1977	2 150	10 000	30 4/	10 030	4.6	0.01	4.6
1978	2 198	10 000	46 4/	10 046	4.5	0.02	4.5
1979	2 248	10 000	67 4/	10 067	4.4	0.03	4.5
1980	2 298	10 000	80 4/	10 080	4.3	0.03	4.4
1981	2 351	6 800	104 4/	6 904	2.9	0.04	2.9
1982	2 405	5 800	105 5/	5 905	2.4	0.04	2.4
1983	2 461	3 600	232 5/	3 832	1.5	0.09	1.6
1984	2 518	6 600	309 5/	6 909	2.6	0.12	2.7
1985	2 576	8 800	288 5/	9 088	3.4	0.11	3.5
1986	2 639	8 800	193 5/	8 993	3.3	0.07	3.4
1987	2 704	8 800	88 5/	8 888	3.2	0.03	3.3

1/ Source: FAO
2/ Sources: FAO Fisheries Department FISHDAB
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3/ included in "Inland Capture" if not specified
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5/ Vincke, M., 1989, (pers.comm.)

3.3 Inland catch range and potential yield

Table 3. INLAND CATCH RANGE AND POTENTIAL YIELD

Water body	Period	Annual catch range (t)	Potential annual yield (t)
Lake Mamoun, Bahr Aouk River, Bahr Kameur River, Ouham River	1983-1985	(1 800-10 000) 6 000	(18 000-30 000) 24 000
Kotto & Sangha Rivers	-	-	- *
Ubangi & Mbomou Rivers	1975	1 800	- *
Other water bodies	-	-	5 000 **

* included in "Other water bodies"
** rough estimate

Total annual yield: from 3 600 t (in case of drought: 1983)
to 12 000 t (Deceuninck, 1985)
Potential annual yield: from 23 000 t (low flood years)
to 35 000 t (high flood years);
29 000 t (mean).
3 500 t (aquaculture).
Sources: see text "Water Bodies Directory".

4. STATE OF THE FISHERY (mainly after Welcomme, 1979a)

4.1 Yield

The nominal catch is approximately 10 000 t, about 80% of which originates from the northern floodplain. There is a small but significant yield from aquaculture which is now widely spread in the south of the country.

4.2 Factors influencing yield

The rivers of the Oubangui Basin are reputedly not very productive. They have no true floodplain and their fisheries are unable to meet the demand for fish in Bangui. The northern floodplains are quite productive and could produce substantially more fish. They are, however, far from the main centres of population and are badly served by roads. Furthermore, they are subject to fluctuating rainfall and were severely affected by the 1981-1984 Sahelian drought. Another constraint is the shortage of fishing equipment.

4.3 Future development possibilities

Inland fisheries should increase in importance in the Central African Republic over the next few years. The productivity of the northern floodplains may be realized to a greater extent and aquaculture could eventually make a significant contribution to the total catch (aquaculture potential annual yield: 3 500 t with the existing ponds).

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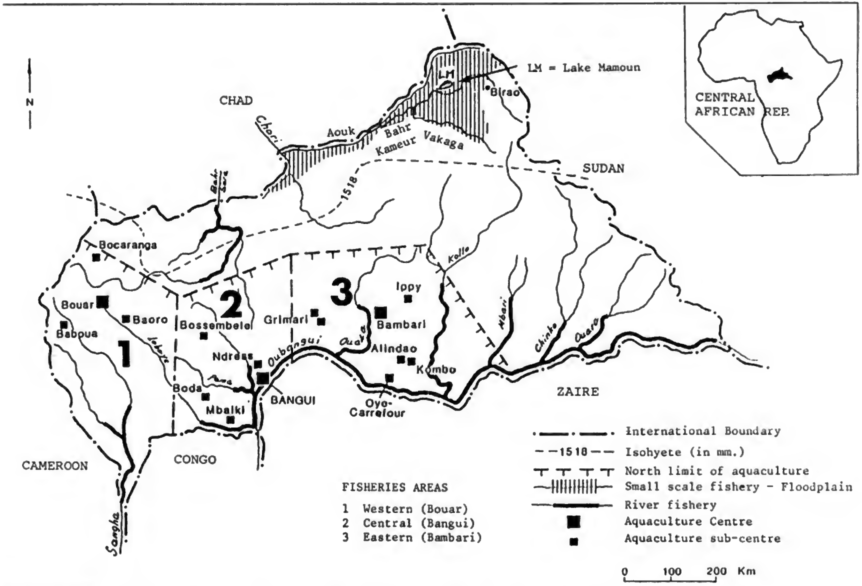

Fig. 1. FISHERY MAP OF THE CENTRAL AFRICAN REPUBLIC
(Vennetier *et al.*, 1984)

6. WATER BODIES DIRECTORY

Lakes

Mamoun

Rivers and Floodplains

Bahr Aouk River and Floodplain
Bahr Kameur River and Floodplain
Kotto River
Ouham River and Floodplain
Sangha River
Ubangi/Oubangui River

Reservoirs

Baoro
Boukoko

LAKE MAMOUN

Geographical data

Location: Northern Central African Republic - 10° 7'N; 21° 55'E
Altitude: 430 m asl
Max.length: 14 km
Max.width: 4 km
Major inflowing river: lateral spillage from Bahr Kameur River
Outflowing river: none; landlocked
Special feature: Non-permanent lake; may dry up during dry season; included in Bahr Kameur floodplain.

Fisheries data

Potential annual yield: See "Bahr Aouk River and Floodplain" below.

BAHR AOUK RIVER AND FLOODPLAIN

(International water)

Geographical data

Source: Extreme southeastern Chad
Altitude: 749 m asl
Total length: 620 km
Countries traversed: Chad, Central African Republic
Major tributaries: Bahr Kameur
Discharges to: Unites with the Bamingui to form the Chari
Special features: Extensive floodplain (area of 370 000 km^2 in Central African Republic) dotted with numerous small lakes. This floodplain is developed jointly with the Salamat River in Chad.

Fisheries data

No. of fishermen: (PNUD/FAO, 1982)
Professional: Bahr Aouk: 350; Vakaga: 300
Part-time (dry season only): circa 1 500.
Total annual catch: In the Central African Republic the composite catch from the Bahr Aouk, the Bahr Kameur, the Ouham and their tributaries and floodplains varies from 1 800 t (during the drought of 1983) to 10 000 t (Deceuninck, 1985), with an average of 6 000 t.
Potential annual yield: (PNUD/FAO, 1982)
Rivers Bahr Aouk, Ouham, Bahr Kameur, Vakaga and associated floodplains:
from 23 000 t (low flood years = 6 000 km^2, 30 kg/ha/yr);
to 30 000 t (high flood years = 10 000 km^2, 30 kg/ha/yr);
mean 24 000 t (mean flood years = 8 000 km^2, 30 kg/ha/yr).

BAHR KAMEUR RIVER AND FLOODPLAIN

Geographical data
Source: Extreme northeastern Central African Republic
Altitude: 1 330 m asl
Total length: 525 km
Countries traversed: Central African Republic
Major tributaries: Gounda, Vakaga, Ouandjia, Bar Oulou, Yata
Discharges to: Bahr Aouk River
Special features: Possesses floodplains along much of its length and its tributaries. Supplies water to Lake Mamoun.

Fisheries data
Total annual catch: See "Bahr Aouk River and Floodplain"
Potential annual yield: See "Bahr Aouk River and Floodplain"

KOTTO RIVER

Geographical data
Source: Chaîne des Mongos Mountains, northeast Central African Republic
Altitude: 1 190 m asl
Total length: 730 km
Drainage area: 78 400 km^2
Countries traversed: Central African Republic
Major tributaries: Bongou, Dja, Pipi
Discharges to: Ubangi River
Volume of discharge at mouth: 136-928 m^3/sec (mean monthly); 1 500 m^3/sec (max)
Flood regime: peak floods in September-October

OUHAM RIVER AND FLOODPLAIN
(International water)

Geographical data
Source: Karre Mountains, western Central African Republic
Altitude: 1 220 m asl
Total length: 790 km
Countries traversed: Central African Republic, Chad
Major tributaries: Bobo, Nanna Bakassa
Discharges to: Chari
Special features: lateral floodplain with numerous small lakes along lower 160 km

Fisheries data
Total annual catch: See "Bahr Aouk River and Floodplain"
Potential annual yield: See "Bahr Aouk River and Floodplain"

SANGHA RIVER
(International water)

Geographical data
Source: Karre Mountians, western Central African Republic
Total length: 1 000 km
Countries traversed: Cameroon, Congo, Central African Republic
Major tributaries: Likuala, Ekela and Dja Rivers
Discharges to: Zaire/Congo River
Volume of discharge at mouth: 700-4 300 m^3/sec

UBANGI/OUBANGUI RIVER

(International water)

Geographical data

Source: The Ubangi River is formed by the confluence of the Uèlè and Bomu Rivers at Yakoma. The Uèlè rises in the mountains near Lake Albert; the Bomu has its source on the frontier between Sudan, Central African Republic and Zaire.

Total length:
Mbomou/Bomu 710 km (Zaire, Central African Republic)
Uèlè 1 210 km (Zaire)
Ubangi 1 060 km (Congo, Central African Republic, Zaire)
The longest continuous course is Uèlè + Ubangi: 2 270 km.

Drainage area: 772 800 km^2
Countries traversed: Congo, Central African Republic, Zaire
Major tributaries: Kotto, Ouaka, Mbori, Chinko
Discharges to: Congo/Zaire at Liranga
Flood regime: August to December, maximum in October (unimodal); low in March-April.
Flow: at Bangui: 800 m^3/sec to 11 000 m^3/sec; mean: 4 000 m^3/sec.
Level variation: 9 m (max); 5.5 m (mean)

Physical and chemical data (Micha, 1973)
Conductivity: 19.5-56 μS/cm
pH: 6.2-6.9
Oxygen: mean at Bangui: 6 mg/l, 75% saturation

Fisheries data
No. of species: 233 in 25 families (Gosse, 1968; Micha, 1973)
Total annual catch: Ubangi River in Central African Republic: 1 800 t (1975)

BAORO RESERVOIR

Geographical data
Location: Central African Republic

BOUKOKO RESERVOIR

Geographical data
Location: Central African Republic

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COMOROS

1. GEOGRAPHY AND CLIMATE

Comoros (with a surface area of 2 170 km^2) consists of 3 main islands and several smaller ones, all of volcanic origin. The islands are variable in topography and include heavily forested hilly terrain, plateaus, lava fields and coastal lowlands.

There is a hot humid monsoon season (November to April) and a drier cooler season (May to October). Cyclones and tidal waves are frequent during the summer.

The economy is almost entirely based on agriculture.

2. HYDROGRAPHY

2.1 Lakes

There are two small permanent lakes on Anjouan Island.

2.2 Rivers, Floodplains and Swamps

There are a few short streams.

2.3 Reservoirs

There are no impoundments.

2.4 Coastal Lagoons

There are no coastal lagoons.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

There is no aquaculture in Comoros (Vincke, 1989, pers. comm.)

3.2 Fish production and per caput supply (see Table 1)

3.3 Inland catch range and potential yield: none

4. STATE OF THE FISHERY

4.1 Yield

There is no significant inland fishery yield of any kind.

4.2 Factors influencing yield

The lack of significant inland water resources.

4.3 Future development possibilities

In view of the large marine potential and lack of inland waters, no inland fishery is likely to develop in the foreseeable future.

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Comoros, 1970-1987

		Nominal Production (t) 2/				Nominal Consumer Supply (kg/person)			
Year	Population '000 1/	Inland capture (none)	Aqua-culture (none)	Marine capture	Total	Inland capture (none)	Aqua-culture (none)	Marine capture	Total
1970	271			2 000	2 000			7.4	7.4
1971	281			2 000	2 000			7.1	7.1
1972	290			2 000	2 000			6.9	6.9
1973	300			2 000	2 000			6.6	6.6
1974	311			2 000	2 000			6.4	6.4
1975	322			3 850	3 850			11.9	11.9
1976	333			3 500	3 500			10.5	10.5
1977	344			4 000	4 000			11.6	11.6
1978	356			4 000	4 000			11.2	11.2
1979	368			4 100	4 100			11.1	11.1
1980	381			4 200	4 200			11.0	11.0
1981	393			4 400	4 400			11.2	11.2
1982	405			4 600	4 600			11.3	11.3
1983	418			4 800	4 800			11.5	11.5
1984	431			5 000	5 000			11.6	11.6
1985	444			5 200	5 200			11.7	11.7
1986	458			5 250	5 250			11.5	11.5
1987	472			5 250	5 250			11.1	11.1

1/ Source: FAO
2/ Source: FAO Fisheries Department FISHDAB

CONGO

1. GEOGRAPHY AND CLIMATE

(Welcomme, 1979a)

The Democratic Republic of Congo (with a surface area of 341 500 km^2) can be divided into four topographical regions:

(a) a coastal plain which extends about 60 km inland to the foothills of the Mayombe Mountains;
(b) the Niara and Ogoué Valleys of the south-centre lie between mountains;
(c) the Bateke Plateau, which serves as watershed to the Ogoué and some of the feeder streams of the Zaire system; and
(d) the Zaire Basin, which occupies the whole of the north of the country.

There is some dry savanna in the centre of the country but most of it is covered with dense rain forest.

There is one long rainy season which lasts for eight months of the year and peaks in April and November. The dry season lasts from June to September. Temperatures are even, but reach a minimum during the dry period.

Congo is primarily an agricultural country although it also has a considerable forestry industry.

2. HYDROGRAPHY (see Figure 1)

2.1 Lakes

There are several minor lakes associated with river floodplains (i.e., Lakes Tele, Cayo, Dinga, Nanga). Brazzaville is located on Pool Malebo (Stanley Pool), a lake-like enlargement of the Zaire/Congo River.

2.2 Rivers, Floodplains and Swamps

The Zaire/Congo River forms the frontier between Zaire and Congo for over 500 km of its lower course. The frontier continues for a further 500 km up the Ubangui. The hinterland of these rivers forms a vast marshland (the Cuvette Congolaise) with extensive seasonal savanna floodplains and permanently flooded gallery forests. The area which covers about 30-45 000 km^2 is drained by the River Sangha, the Likouala and Likouala-aux-Herbes as well as by numerous smaller rivers. Of several smaller coastal rivers, the Kouilou is the largest.

2.3 Reservoirs

There is one impoundment on the Bouenza (tributary of Kouilou) at Moukoukoulou and a second is planned at Sounda on the Kouilou.

2.4 Coastal Lagoons

There are three small lagoons: Conkouati, Loubi and Malonda.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

In 1986, 525 private fish farmers, exploiting 1 454 ponds for a total area of 4 479 ares and production of 45 t/yr, were counted by an FAO/UNDP project. Ten aquaculture centres are managed by the Government with FAO/UNDP assistance. An industrial fish farm is in operation in Brazzaville and produces 15 t *Oreochromis niloticus* per year (Deceuninck, 1988). In 1987, 115 t *Oreochromis niloticus* were produced in the whole country (Vincke, 1989, pers.comm.).

3.2 Fish production and per caput supply

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Congo, 1970-1987

		Nominal Domestic Production (excluding exports) (t) 2/				Nominal Consumer Supply (excluding imports and exports) (kg/person)			
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Marine capture	Total	Inland capture	Aqua-culture 3/	Marine capture	Total
1970	1 201	3 000	- 4/	9 700	12 700	2.5	-	8.0	10.5
1971	1 230	6 000	-	7 600	13 600	4.9	-	6.1	11.0
1972	1 259	7 000	-	14 000	21 000	5.5	-	11.1	16.6
1973	1 289	8 000	-	15 500	22 500	5.4	-	12.0	17.4
1974	1 320	8 000	-	14 794	22 794	6.0	-	11.2	17.2
1975	1 352	8 000	-	15 103	23 103	5.9	-	11.1	17.0
1976	1 385	8 000	-	17 869	25 869	5.7	-	12.9	18.6
1977	1 419	8 000	-	15 364	23 364	5.6	-	10.8	16.4
1978	1 454	8 000	-	16 297	24 297	5.5	-	11.2	16.7
1979	1 491	8 000	-	19 630	27 630	5.4	-	13.1	18.5
1980	1 529	8 000	-	20 965*	28 965	5.2	-	13.7	18.9
1981	1 568	12 000	-	17 665*	29 665	7.7	-	11.2	18.9
1982	1 609	11 956	44 5/	18 835*	30 835	7.4	0.03	11.7	19.1
1983	1 651	11 989	11 5/	21 702*	33 702	7.3	0.006	13.1	20.4
1984	1 695	11 971	29 5/	19 297	31 297	7.1	0.02	11.4	18.5
1985	1 740	13 500	39 5/	16 336	29 875	7.7	0.02	9.4	17.1
1986	1 788	11 918	82 5/	17 994	29 994	6.7	0.04	10.0	16.7
1987	1 837	13 385	115 5/	17 513	31 013	7.3	0.06	9.5	16.8

1/ Source: FAO
2/ Source: FAO Fisheries Department, FISHDAB
3/ included in "Inland capture" if not specified
4/ - = data not available
5/ Vincke, 1989 (pers.comm.)
* Marine exports were: 1980: 850t; 1981: 60 t; 1982: 730 t; 1983: 500 t

3.3 Inland catch range and potential yield

See Table 2.

Table 2. INLAND CATCH RANGE AND POTENTIAL YIELD

Water body	Period	Annual catch range (t)	Potential annual yield (t) *
Lake Louandjili	-	-	3
Pool Malebo	-	1 000	-
Lake Ndembo	-	-	3
Cuvette Congolaise Floodplain and Likouala, Likouala-aux-Herbes and Sangha Rivers	-	10 000-15 000	60 000-100 000**
Other water bodies	-	-	10 000-15 000***

No specific data available for:
Lakes Cayo, Dinga, Loufoualeba, Nanga, Tchipounga, Tele, and Youbi;
Rivers Congo, Kouilou, Ogooue and Ubangi;
Lagoons Conkouati and Malonda.

* when not specified, included in "other water bodies"
** based on 15-25 kg/ha/yr; see text
*** rough estimate.

Total annual yield: 11 000-16 000 t
12 000 (Deceuninck, 1988)

Potential annual yield: 70 000-115 000 t
100 000 (Corsi *et al.*, 1980)

4. STATE OF THE FISHERY (mainly after Welcomme, 1979a)

4.1 Yield

There is little doubt that the present catch from Congo is very low, relative to the potential.

4.2 Factors influencing yield

The main fishery is at present concentrated on the extensive floodplains of the Congo Basin (centered around Mossaka, Loukolela and Djoundou), but are fished at a low level because of their inaccessibility and low population densities. Some small coastal lacustrine bodies are in need of environmental rehabilitation.

4.3 Future development possibilities

The potential for increasing catches is very great. The floodplain complex of the Sangha/Likouala/Likouala-aux-Herbes (Cuvette Congolaise) Rivers is one of the most important undeveloped inland fisheries in Africa. The 30-40 000 km^2 of floodplains are partly savanna and although the gallery forests and flooded rain forests are covered with blackwaters, the savanna plains are flooded by white-waters. Even a conservative estimate of sustainable potential (15-25 kg/ha) gives a yearly catch range of 60-100 000 t. Because of its inaccessibility and the difficulties of operating there, the development of the area may take some time. However, current activities for the creation of pre-cooperative groups and the introduction of new fishing methods promise a rapid development of the sector in the near future.

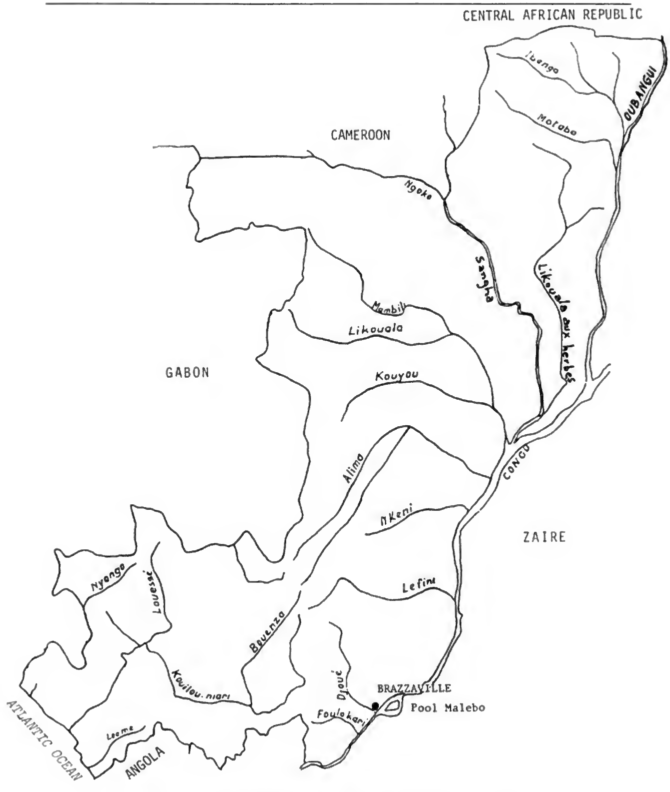

Fig. 1. HYDROLOGICAL NETWORK OF REPUBLIC OF CONGO
(Stauch, 1963)

5. KEY BIBLIOGRAPHY

Corsi *et al.*, 1980

6. WATER BODIES DIRECTORY

Lakes

Cayo
Dinga
Louandjili
Loufoualeba
Pool Malebo (= Stanley Pool)
Nanga
Ndembo
Tchipounga
Tele
Youbi

Rivers

Congo/Zaire
Kouilou
Likouala (and Floodplain)
Likouala-aux-Herbes (and Floodplain)
Ogooue
Sangha (and Floodplain)
Ubangi/Oubangui

Lagoons

Conkouati
Loubi (=Djeno)
Malonda

LAKE CAYO

Geographical data

Location: Congo coastal plain - 4° 55'S; 12° 0'E
Surface area: 16.5 km^2
Depth: 4.5 m (max.); 4.2 m (mean, at max. volume)
Volume: 30-70 x 10^6 m^3 (varies seasonally)
Max. length: 7.5 km
Max. width: 5.0 km
Annual fluctuation in level: 1.8 m
Major inflowing river: Loémé (from Lake Loufoualeba)
Outflowing river: Loémé (to Malonda Lagoon)
Special features: Heavily infested with papyrus

Physical and chemical data

Surface temperature: 26-35.5° C
Oxygen: low (0-4.5 mg/l) oxygen levels due to decomposition of dead plant material

Fisheries data

No. of fish species: only *Protopterus dolloi* present in lake.

LAKE DINGA

Geographical data

Location: Congo, coastal plain - 4° 11'S; 11° 53'E
Altitude: circa 400 m asl
Surface area: 4.7 km^2
Max. length: 4.5 km
Max. width: 1.5 km
Major inflowing river: lateral spillage from Kouilou River

LAKE LOUANDJILI

Geographical data

Location: Congo coastal plain - 4° 21'S; 11° 37'E
Depth: 9.0 m (max.)
Surface area: about 2 km^2

Physical and chemical data

pH: 5.40-6.1
Temperature: 30.0-31.9° C

Fisheries data

Potential annual yield: 3 t (15 kg/ha, acid water: Welcomme, 1989, pers.comm.)

LAKE LOUFOUALEBA

Geographical data

Location: Congo coastal plain - 4° 53'S; 11° 57'E
Surface area: 5.7 km^2
Depth: 4.5 m (max.); 3.0 m (mean, at max. volume)
Volume: 8-17 x 10^6 m^3
Max. length: 5 km
Max. width: 2 km
Annual fluctuation in level: 1.3 km
Major inflowing rivers: Loèmè, Koulombo
Outflowing river: Loèmè (to Lake Cayo)
Special features: Heavily infested with papyrus

Physical and chemical data

Temperature: 25.5-32° C
Oxygen: low (<4 mg/l) oxygen levels, due to decomposition of dead plant material

Fisheries data

No. of fish species: only *Protopterus dolloi* present in lake.

POOL MALEBO (= STANLEY POOL)

(International water)

Geographical data

Location: Congo, Zaire - 4° 15'S; 15° 28'E
Surface area: 550 km^2 (330 km^2 in Congo; 220 km^2 in Zaire)
Depth: 20 m (max.); 3 m (mean)
Max. length: 40 km
Max. width: 20 km
Shoreline: 95 km
Major inflowing river: Congo/Zaire
Special features: Pool Malebo is a riverine lake, with a large central island (Ile Mbamou) and several smaller sandbanks which are subject to inundation.

Fisheries data

Total annual catch: circa 1 000 t from Congo waters

LAKE NANGA

Geographical data
Location: Congo, coastal plain - 4° 13'S; 11° 48'E
Altitude: circa 300 m asl
Surface area: circa 15 km^2
Depth: 2 m (max.); 1.5-2.0 m (mean, varies seasonally)
Max. length: 8 km
Max. width: 2 km
Major inflowing river: Louandjili
Outflowing river: Louandjili (tributary of Kouilou)

Physical and chemical data
pH: 6.35-7.20
Temperature: 27-34° C

LAKE NDEMBO

Geographical data
Location: Congo, coastal plain - 4° 21'S; 11° 39'E
Depth: 6.5 m (max.)
Surface area: circa 2 km^2

Physical and chemical data
pH: 5.21-5.82
Temperature: 30.8-32.5° C

Fisheries data
Potential annual yield: 3 t (15 kg/ha, acid water: Welcomme, 1989, pers.comm.)

LAKE TCHIPOUNGA

Geographical data
Location: Congo coastal plain - 4° 43'S; 11° 54'E
Surface area: 0.08 km^2

LAKE TELE

Geographical data
Location: Congo, Cuvette Congolaise (Central Basin) - 1° 20'N; 17° 9'E
Surface area: 20 km^2
Max. length: 6.5 km
Max. width: 4.5 km
Main inflowing river: lateral flood spillage from Bali River
(tributary of Likouala-aux-Herbes River)

LAKE YOUBI

Geographical data

Location: Congo, coastal plain - 4° 11'S; 11° 40'E

Surface area: 3.5 km^2

Max. length: 2.5 km

Max. width: 2.0 km

CONGO/ZAIRE RIVER

(International water)

See also "ZAIRE RIVER" under "ZAIRE" (country) for more detailed data.

Geographical data

Source: The longest continuous stream is: Chambezi River, Lake Bangweulu, Luapula River, Lake Mweru, Luvua River, Lualaba River. The Lualaba River changes its name to Congo/Zaire at Kisangani, 2 000 km from the mouth. In the Congo it is navigable from Brazzaville to the Oubangui mouth.

Altitude: The highest source is that of the Lualaba - 1 535 m asl.

Total length: 4 700 km

Drainage area: 4 014 500 km^2

Area of water: (including Ubangui basin)

Congo/Zaire	17 000 km^2
Tributaries of Congo/Zaire	4 100 km^2
Ubangi and tributaries	1 300 km^2
Other rivers	8 500 km^2
Kasai and tributaries	3 100 km^2

Countries traversed: The basin covers parts of Angola, Burundi, Cameroon, Central African Republic, Congo, Rwanda, Tanzania, Zaire, Zambia.

Major tributaries: Alima, Aruwimi, Elila, Itimbiri, Kwa, Lomami, Lowa, Lufira, Lukuga, Lulonga, Luvua, Mongala, Sangha, Ruki, Ubangi

Discharges to: South Atlantic - 6° S; 12° E

Volume of discharge at mouth: 22-67 000 (mean 39 160) m^3/sec

Suspended silt load: 50 500 000 t/yr

Flood regime: Bimodal floods with peaks in May and December

Special features: Lakes Kivu, Tanganyika, Bangweulu, Mweru, Maji Ndombe, Pool Malebo, Upemba, Tumba. Waterfalls: Portes d'Enfer, Wagenia, numerous cataracts; dams on nearly all tributaries.

Physical and chemical data

pH: Both pH and conductivity vary considerably in the different water courses of the system. pH may be as low as 4.4 in flooded forests; 5.5 in upper course; 6.5 in middle course; 4.00-6.5 in Tshwapa River; 7.05-7.8 at Yangambi. *
(* Data provided by Gosse (1963) for the Zaire River at Yangambi, and by Matthes (1964) for the Tshwapa River.)

Ionic composition: (Meybeck, 1978)

	mg/l
Ca	2.40
Mg	1.25
Na	1.70
K	1.10
HCO_3	11.20
Cl	2.85
SO_4	2.95
SiO_2	9.80

KOUILOU RIVER

Geographical data
Source: Congo (Zala Mountains)
Altitude: 880 m asl
Total length: 605 km
Drainage area: 60 000 km^2
Countries traversed: Congo
Major tributaries: Louessè, Niari, Bouenza
Discharges to: Atlantic Ocean. 4° 28'S; 11° 42'E, Coastal plain
Volume of discharge at mouth: 700 m^3/sec mean (300-1 000 m^3/sec)
Flood regime: two peaks: April-May and November-December
Special features: Lateral floodplains in lower section with Lakes Dinga and Nanga. There is an impoundment at Moukoukoulou on the Bouenza, and a second is planned at Sounda on the Kouilou.

LIKOUALA RIVER AND FLOODPLAIN

Geographical data (see Fig. 2)
Source: northwestern Congo
Altitude: 780 m asl
Total length: 480 km
Countries traversed: Congo
Major tributaries: Kouyou, Mambili, Lengouè
Discharges to: Congo/Zaire River (1° 11'S; 16° 49' E)
Special features: Extensive lateral floodplain (Cuvette Congolaise) along lower course. The combined area inundated twice yearly along the lower reaches of the Sangha, Likouala-aux-Herbes and Likouala Rivers is 30-40 000 km^2.

Physical and chemical data (Stauch, 1963; Corsi, *et al.*, 1980)
pH: Likouala-Mossaka: 4.9-5.6
Temperature: Likouala-Mossaka: 25.5-27.5° C
Conductivity: Likouala-Mossaka: 8.8 μS/cm

Fisheries data
No. of fishermen: 7-10 000 for combined floodplain
Total annual catch: 10-15 000 t from combined floodplain
Potential annual yield for 40 000 km^2 combined floodplain:
60 000 t (15 kg/ha - Welcomme, 1989, pers.comm.) to
100 000 t (20-25 kg/ha - Corsi, et al., 1980, for acid, brown and poor-in-minerals water).

LIKOUALA-AUX-HERBES RIVER AND FLOODPLAIN

Geographical data
Source: northeast Congo (see Fig. 2)
Altitude: 470 m asl
Total length: 475 km
Countries traversed: Congo
Major tributaries: Tanga, Moudongoumo, Bali
Discharges to: Sangha River (0° 50'S; 17° 12'E)
Special features: Lake Tele on Bali tributary. Extensive lateral floodplain (Cuvette Congolaise) along lower course. The combined area inundated twice yearly along the lower reaches of the Sangha, Likouala-aux-Herbes and Likouala Rivers is 30-40 000 km^2.

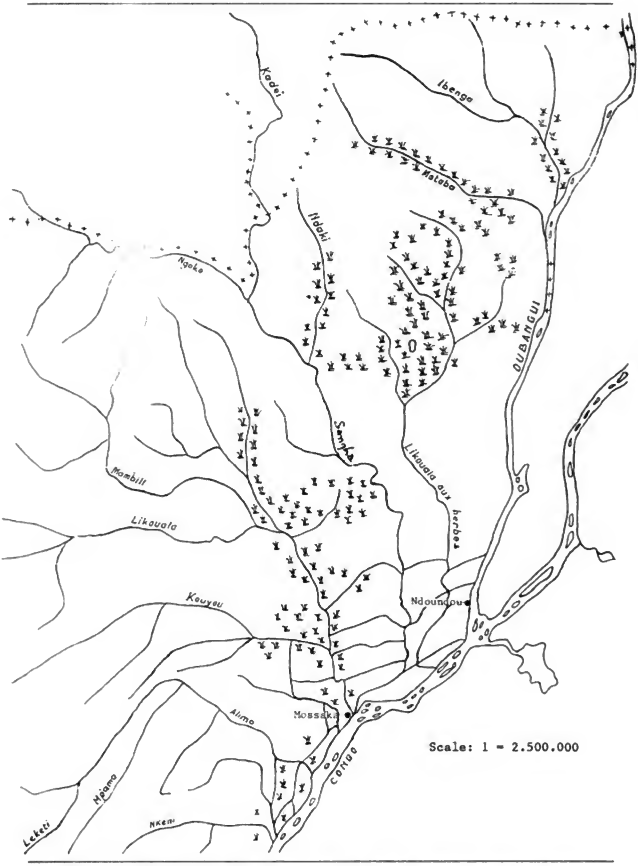

Fig. 2. HYDROLOGICAL NETWORK OF CENTRAL BASIN (CUVETTE CONGOLAISE)
(Stauch, 1963)

LIKOUALA-AUX-HERBES RIVER AND FLOODPLAIN (cont.)

Physical and chemical data (Stauch, 1963; Corsi *et al.*, 1980)
pH: 5-6.4
Conductivity: 25.3 µS/cm

Fisheries data
No. of fishermen: 7-10 000 for combined floodplain
Total annual catch: 10-15 000 t from combined floodplain
Potential annual yield for: 40 000 km^2 combined floodplain:
60 000 t (15 kg/ha - Welcomme, 1989, pers.comm.) to
100 000 t (20-25 kg/ha - Corsi *et al.*, 1980, for acid, brown and poor-in-minerals water).

OGOOUE RIVER
(International water)

Geographical data
Source: Congo (Leketi, Zala and Massa Mountains)
Altitude: 880 m asl
Total length: 920 km (100 km in Congo)
Drainage area: 205 000 km^2 (at Lambarene)
Countries traversed: Gabon, Congo
Major tributaries: Ivindo, Ngounié, Ofooué
Discharges to: Atlantic Ocean - 1° 2'S; 8° 53'E
Volume of discharge at mouth:
13 500 m^3/sec (max.);
1 950-7 340 m^3/sec (mean monthly);
Flood regime: Bimodal flood with peaks in April-May and November-December
Special features: Large floodplain in lower reach with several associated lakes (Anengue, Avanga, Onangue, Gomé, Nkonie, Azingo and Nguene). Other swampy/floodplain depressions associated with Ngounié and Ivindo tributaries (the latter mostly in Congo).

SANGHA RIVER AND FLOODPLAIN
(International water)

Geographical data
Source: Karre Mountains, western Central African Republic (see Fig. 2)
Total length: 1 000 km
Countries traversed: Cameroon, Congo, Central African Republic
Major tributaries: Likuala, Ekela and Dja Rivers
Discharges to: Zaire/Congo River
Volume of discharge at mouth: 700-4 300 m^3/sec
Special features: Extensive lateral floodplain (Cuvette Congolaise) along lower course in Congo. The combined area inundated twice yearly along the lower reaches of the Sangha, Likouala-aux-Herbes and Likouala Rivers is 30-40 000 km^2.

Physical and chemical data (Corsi, *et al.*, 1980)
pH: Sossolo: 6.2
Conductivity: 43.7 µS/cm

SANGHA RIVER AND FLOODPLAIN (cont.)

Fisheries data
No. of fishermen: 7-10 000 for combined floodplain
Total annual catch: 10-15 000 t from combined floodplain
Potential annual yield: for 40 000 km^2 combined floodplain:
60 000 t (15 kg/ha - Welcomme, 1989, pers.comm.) to
100 000 t (20-25 kg/ha - Corsi, *et al.*, 1980, for acid, brown and poor-in-minerals water).

UBANGI/OUBANGUI RIVER

(International water)

Geographical data
Source: The Ubangi is formed by the confluence of the Uèlè and Bomu Rivers at Yakoma. The Uèlè rises in the mountains near Lake Albert; the Bomu has its source on the frontier between Sudan, Central African Republic and Zaire.
Total length: Mbomou/Bomu: 710 km (Zaire, Central African Republic)
Uèlè: 1 210 km (Zaire)
Ubangi: 1 060 km (Congo, Central African Republic, Zaire)
The longest continuous course is the Uèlè + the Ubangi (2 270 km)
Drainage area: 772 800 km^2
Countries traversed: Congo, Central African Republic, Zaire
Major tributaries: Kotto, Ouaka, Mbori, Chinko
Discharges to: Congo/Zaire at Liranga
Flood regime: August to December, max. in October (unimodal); low in March-April
Flow at Bangui: 800 to 11 000 m^3/sec; mean: 4 000 m^3/sec
Level variation: 5.5 m (mean); 9 m (max.)

Physical and chemical data - at Ndjoundou (Corsi, *et al.*, 1980)
pH: 7.1
Conductivity: 55.5 μS/cm
Oxygen: mean at Bangui: 6 mg/l, 75% saturation (Micha, 1973)

Fisheries data
No. of species: 233 in 25 families (Gosse, 1968; Micha, 1973)

CONKOUATI LAGOON

Geographical data
Location: Congo, Coastal plain - 3° 58'S; 11° 20'E
Surface area: 24 km^2
Depth: 5 m (max.); 2.5 m (mean)
Volume: 60 x 10^6 m^3
Annual fluctuation in level: 0.3 m
Max. length: 17 km
Max. width: 4.5 km
Major inflowing rivers: Niambi, Ngongo, Louvandzi
Outflow: to Atlantic Ocean

Physical and chemical data
Salinity: 3.17-32.94 ^{o}/oo

LOUBI (= DJENO) LAGOON

Geographical data

Location: Congo, coastal plain - 4° 54'S; 11° 55'E

Special features: Highly polluted by petroleum wastes which have gravely affected the ichthyofauna.

MALONDA LAGOON

Geographical data

Location: Congo, coastal plain - 4° 57'S; 11° 57'E
Surface area: 0.05 km^2
Depth: 2.5 m (max.); 0.8 m (mean)
Volume: 40 000 m^3
Annual fluctuation in level: 0.5 m
Major inflowing river: Loèmè (from Lake Cayo)
Outflow: 50 m-long-canal to Atlantic Ocean
Special features: Low (<4.0 mg/l) oxygen levels due to high BOD input from Lakes Cayo and Loufoualeba, upstream.

Physical and chemical data

Surface temperature: 27.5-34° C
Salinity: <3 °/oo

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7. BIBLIOGRAPHY

Corsi, *et al.*, 1980
Deceuninck, 1988
Gosse, 1963; 1968
Matthes, 1964
Meybeck, 1978
Micha, 1973
Stauch, 1963

KENYA

1. GEOGRAPHY AND CLIMATE

The surface area of Kenya is 569 250 km^2. The western and central parts of Kenya consist of highland plateaus which are divided from north to south by the Great Rift Valley. The plateaus are crowned by mountains, of which Mount Kenya (5 200 m) is the highest. The highlands slope downward to the east.

Kenya has a wide range of climates. The north and much of the east of the country are desertic with little rainfall and high temperatures. The highland plateaus have warm temperate climates with two well marked rainy seasons: February-May and October-December. The coast has a monsoon climate with a prolonged wet season peaking in May.

The highlands of Kenya are used for agriculture, whereas the lowland areas tend to be occupied by pastoral peoples. Large areas of the country have been reserved as game parks and much of the north is desertic and supports only very limited population.

2. HYDROGRAPHY (see Figure 1)

2.1 Lakes (Welcomme, 1979a) (see Table 1)

The major Kenyan lakes fall into two main groups: (a) Lake Victoria; and (b) the Rift Valley lakes. Kenya possesses 69% of Lake Victoria. A considerable portion of this is located in the shallow and productive Kavirondo Gulf. The larger Rift Valley lakes are Lakes Turkana, Baringo, Bogoria, Nakuru, Elementeita, Naivasha and Magadi. One small lake, Lake Jipe, lies between Kenya and Tanzania (about half in each country). Many other small lakes are dotted around the country, and there are several on the lower floodplains of the Tana and Sabaki Rivers.

2.2 Rivers, Floodplains and Swamps (Balarin, 1985a; Welcomme, 1979a)

The drainage system of Kenya is largely influenced by the Great Rift Valley and five drainage basins are evident (see Figure 1; Table 2):

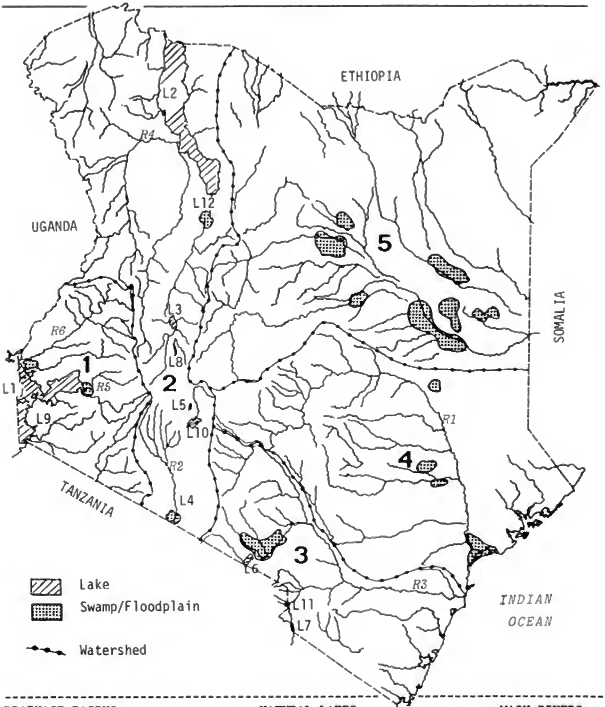
Lake Victoria: the Lake Basin is a multi-river basin containing eight rivers of significant size. These rivers drain about 47% of the total of Kenya's runoff, carrying it westward into Lake Victoria. Their catchment comprises the whole of the area west of the Rift Valley, delineated by Mount Elgon in the North.

Rift Valley: an area with its own internal drainage, discharging northwards into Lake Turkana and southwards into Lake Natron, with several sub-drainage rivers and lakes. Although one of the larger catchments, its mean annual runoff is very low.

Athi River: the southern catchment east of the Rift Valley, draining from the central highlands to the Indian Ocean.

Tana River: drains eastward from Mount Kenya to the Indian Ocean; one of the largest rivers with the second highest MAR, 7% of rainfall.

Ewaso Ngiro: the largest but driest catchment in Kenya, it extends from north of Mount Kenya and the Aberdares to empty into the Iorian swamp. In exceptional floods, flows continue into Somalia.



DRAINAGE BASINS

1 Lake Victoria
2 Rift Valley
3 Athi-Sabaki River
4 Tana River
5 Ewaso Ngiro

NATURAL LAKES

L1 Victoria
L2 Turkana
L3 Baringo
L4 Magadi
L5 Naivasha
L6 Amboseli*
L7 Jipe
L8 Hannington (Bogoria)
L9 Nakuru*
L10 Elementaita
L11 Chala
L12 Logipi
* = seasonal

MAIN RIVERS

R1 Tana
R2 Ewaso Ngiro
R3 Sabaki (Athi)
R4 Turkwel
R5 Migori
R6 Nzoia

Fig. 1. **MAJOR LAKES, RIVERS AND DRAINAGE BASINS IN KENYA**
(adapted from: Survey of Kenya, 1970)

Table 1. MORPHOLOGICAL DATA AND USE OF MAJOR LAKES AND RESERVOIRS
(Balarin, 1985a, based on Govt. of Kenya, 1979a; Limiri, pers.comm)

Water body*		Drainage basin	Volume ($10^6/m^3$)	Area (km^2)	Fishery potential (t/yr)	Use a/	Altitude ab. MSL m
Natural Lakes							
L.1	Victoria	I		3 785		w,c,r,f	1 134
L.2	Turkana	II		6 405		f,w,r	375
L.3	Baringo	II		130		f,w,r,i	975
L.4	Magadi	II		104		c	580
L.5	Naivasha	II		115-191		f,w,r,(p)	1 875
L.6	Amboseli b/	III		0-115		r	1 190
L.7	Jipe	III		40	500	f	700
L.8	Hannington	II		34		r (p)	960
L.9	Nakuru b/	II		5-50		r,f	1 757
L.10	Elementaita	II		18-21		r	1 783
L.11	Chala			4	200	f	
L.12	Logipi			34			
Reservoirs							
B.1	Masinga	IV	1 560	120.0	480	p,f,i	
B.2	Kamburu	IV	156	15.0		p,f	
B.3	Gitaru	IV	20	3.1		p,f	
B.4	Kindaruma	IV	16	2.4		p,f	
B.5	Sasumua	IV					
B.6	Munyu c/	III		499.0	175	p,i,f	
B.7	Kiambere c/	IV		25.0	40-60	p,i,f	
	Wanjii	IV				p	
	Grand Falls c/	IV		119		p	
	Adamson's Falls c/	IV		102		p	
	Koreh Falls c/	IV		190		p	

* Numbers refer to Figure 1.

a/ i=irrigation; c=commercial/industrial; f=fishery; r=recreation; p=power generation; w=water supply

b/ seasonal

c/ proposed

The rivers of Kenya fall into two main groups:

(a) *coastal rivers* - the Sabaki (Athi, Galana) River with a broad floodplain in its lower reaches, and the Tana River;

(b) *rivers flowing into Lake Victoria* - of which the Nzoia, Yala and Sio Rivers are the most important.

Several seasonal rivers, such as the Turkwell, drain the western rift wall toward Lake Turkana. FAO/UNDP (1966) estimated a total of about 3 000 km of rivers in the country.

The rivers exhibit seasonal flow patterns characteristic of the peak wet seasons, generally flooding from March to May and from October to December.

Table 2. CATCHMENT AREA AND MEAN ANNUAL RUNOFF FOR MAJOR RIVERS AND DRAINAGE BASINS

(Balarin, 1985a, based on: Bhushan, 1982; Govt. of Kenya, 1970; Ongwenyi, 1979; Litterick, 1981; Coche & Balarin, 1982; Survey of Kenya, 1970)

DRAINAGE BASIN/ River system	Major River Systems			Total catchment		Rainfall runoff			Runoff as % of rain-fall
	Length (km)	Catchment (km^2)	MAR (million m^3)	('000 km^2)	%	Mean rainfall (mm/yr)	Total MAR* 10^6 m^3	Total MAR* % of total	
I. LAKE VICTORIA									
Nzoia	258	12 696	1 777	45	8.4	1 245	6 706-7 290	46.9	12
Mara	290	(8 941)	1 038						
Gucha (Migori)		6 368	952						
Kibos		4 992	68						
Sondu	110	3 489	845						
Nyando		3 450	247						
Yala	180	3 262	1 114						
Sio (Malakisi)		2 326	287						
Kuja	90								
II. RIFT VALLEY									
Molo			39						
Suam-Turkwel	380	20 720		127	21.8	535	806-860	6.0	1
Gilgil			28						
Ewaso Ngiro (S)	140								
Perkerra			125						
Melawa	110		184						
Arror Kerio	350								

Table 2. (cont.)

DRAINAGE BASIN/ River system	Major River Systems			Total catchment		Rainfall runoff			Runoff as % of rain-fall
	Length (km)	Catchment (km^2)	MAR (million m^3)	('000 km^2)	%	Mean rainfall (mm/yr)	Total MAR * 10^6 m^3	% of total	
III. ATHI RIVER									
Athi-Galana-Sabaki	547	44 029	750	70	12.0	585	1 294	9.0	3
Voi	210								
Tsavo			138						
Njoro-Lumi			293						
IV. TANA RIVER									
Tana	708	62 160	4 700	132	22.7	535	4 700	32.9	7
V. EWASO NGIRO									
Ewaso Ngiro (N)	830	56 980	740	205	35.1	255	740	5.2	2
Total	(4 203+)			579			14 299- 14 830	100.0	
Mean						631			5

* MAR: Mean Annual Runoff

There are extensive seasonal floodplains and swamps in Kenya which are water-filled during the rainy season for about 3-4 months of the year. The extent of these areas is not known. Similarly, there is a large number of pans and water holes, natural depressions which temporarily store rain runoff.

The groundwater reserves are extensive at an average depth of 78 m below surface. This implies a water table deeper than in most places in Africa. But a large number of shallow wells is also common. There is an extensive domestic water supply network throughout the densely populated areas.

2.3 Reservoirs (see Table 1)

There are four important hydroelectric impoundments on the upper Tana River. Also listed in Table 1 are a number of the larger man-made reservoirs. Those considered are built mainly for hydroelectric power (HEP) schemes or irrigation projects, but there are numerous smaller water storage units dispersed throughout the country (Balarin, 1985a). Welcomme (1979a) suggests over 3 000 farm dams, as reported by Rhodes (FAO/UNDP, 1966).

2.4 Coastal Lagoons

There are several small seasonal lagoons in coastal areas at the mouths of the Tana and Galana Rivers. In addition, large coastal tracts of tidal mangrove swamps exist (combined area of over 12 960 km^2 estimated by Bell and Canterbery, 1976).

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

FAO/UNDP (1966) indicates that in 1965 there were between 12 500 and 22 000 small rural ponds with a combined surface area of between 280 and 500 ha. Most of the ponds were small and many were abandoned. In 1975 official estimates suggest over 28 000 fish ponds ranging from 0.04 to 0.8 ha (Kagai, 1975).

The most recent official statistics (1986 Fisheries Statistical Bulletin, Govt. of Kenya) indicates that fish farming production reached 980 t. A recent FAO re-evaluation (Vincke, pers. comm., 1989) estimates the actual aquaculture production at a lower level: 224 t in 1986, 210 t in 1987. In 1987, 5 t of common carp (*Cyprinus carpio*), 121 t of tilapia (mainly *Oreochromis niloticus*), 80 t of trout (*Salmo gairdneri*) and 4 t of shrimps (*Penaeus* spp.) were produced.

3.2 Fish production and per caput supply

See Table 3.

Table 3. FISH PRODUCTION AND PER CAPUT SUPPLY - Kenya, 1970-1987

		Nominal Domestic Production (excluding exports) (t) 2/				Nominal Consumer Supply (excluding imports and exports) (kg/person)			
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Marine capture	Total	Inland capture	Aqua-culture 3/	Marine capture	Total
1970	11 290	25 800	- 4/	7 900	33 700	2.3	-	0.7	3.0
1971	11 736	21 300	-	6 900	28 200	2.8	-	0.6	2.4
1972	12 199	22 300	-	7 700	30 000	2.8	-	0.6	2.4
1973	12 681	25 000	-	4 000	29 000	2.0	-	0.3	2.3
1974	13 182	25 800	-	3 600	29 400	1.9	-	0.3	2.2
1975	13 703	22 810	-	4 531	27 341	1.7	-	0.3	2.0
1976	14 259	36 872	-	4 149	41 021	2.6	-	0.3	2.9
1977	14 844	38 443	-	4 339	42 779	2.6	-	0.3	2.9
1978	15 456	41 760	-	4 634	46 394	2.7	-	0.3	3.0
1979	16 096	47 688	-	4 055	51 743	3.0	-	0.2	3.2
1980	16 766	42 171	-	5 552	47 723	2.5	-	0.3	2.8
1981	17 465	51 385	-	6 316	57 701	2.9	-	0.4	3.3
1982	18 196	73 822	195 5/	7 512	81 529	4.1	0.01	0.4	4.5
1983	18 960	90 867	201 5/	7 070	98 138	4.8	0.01	0.4	2.5
1984	19 761	84 706	207 5/	6 041	90 954	4.3	0.01	0.3	4.6
1985	20 600	99 551	213 5/	6 196	105 960	4.8	0.01	0.3	5.1
1986	21 483	113 362	224 5/	6 212	119 798	5.3	0.01	0.3	5.6
1987	22 405	124 096	210 5/	6 875	131 181	5.5	0.01	0.3	5.8

1/ Source: FAO

2/ Source: FAO, based on: Statistical Bulletin, Fisheries Department, Ministry of Tourism and Wildlife, Govt. of Kenya.
Note: FAO Yearbook, Fishery Statistics, Vol. 62, 1986): Kenya. Landings recording system for Lake Victoria which accounts for 70% of the total catch, considered unreliable. Increased catch recorded in 1986 largely due to improved coverage.

3/ included in "Inland capture" if not specified

4/ - = data not available

5/ Vincke, 1989, pers.comm.

3.3 Inland catch range and potential yield

Table 4. INLAND CATCH RANGE AND POTENTIAL YIELD

Water body	Period	Annual catch range (t) 1/	Potential annual yield (t) 1/
Lake Baringo	1985	317	900-3 500
	1986	154	
Lake Chala	1982	90	
	1983-86	10-1	
Lake Jipe	1983-86	463-128	100-300
Lake Naivasha	1986	576	1 000-4 000
Lake Turkana	1986	7 324	5 000-20 000
Lake Victoria	1986	103 163 4/	25 000-40 000
Ewaso Ngiro River and Ngare Ngiro Swamp	1965	300	-
Sabaki River	1960	300	-

Table 4. (cont.)

Water body	Period	Annual catch range (t) 1/	Potential annual yield (t) 1/
Aruba Reservoir	1965	20	-
Lessos Reservoir	1965	50	-
Miscellaneous Lakes, Rivers, including Reservoirs	1986	870 2/	2 600-23 000 3/
Aquaculture	1987	210	-

No information available for:
Lakes Kabongo, Kanyaboli, Kwenia, Logipi and Nakuru;
Rivers Migori, Nzoia, Tana, Turkwel and Lorian Swamp;
Reservoirs Gtaru, Kamburu, Kindaruma and Masinga.

1/ Source: see text "Water bodies directory"
2/ Source: Statistical Bulletin, Fisheries Dept., Govt. of Kenya
3/ Source: Balarin, 1985a
4/ see Note 2, Table 3

Total annual yield: using most recent data: 113 094 t (see also Table 3)

Potential annual yield: 34 600-90 800 t

4. STATE OF THE FISHERY

(mainly adapted and updated from Balarin, 1985a)

4.1 Yield

In 1986, 94.5% of the total landings originated from freshwater sources and 5.5% from marine fisheries. Lake Victoria produced 86.1% of this catch and Lake Turkana 6.1%. Other lakes and rivers contributed 2.3% only (based on 1986 Fisheries Statistical Bulletin, Kenya).

The increase in recent years in fishery landings are evident from Table 3. Until 1975, total catch remained below 30 000 t/yr but by 1981 the catch had doubled. It has increased even more dramatically in recent years. The upward trend represents a 28% per year increase in output but this has been primarily in the freshwater catch. Marine landings have remained static: between 4 000 and 7 000 t/yr.

The fisheries status has been reviewed on numerous occasions, notably by FAO/UNDP (1966), Fisheries Department (1977), FAO (1980a), KMFRI (1981) and more recently by Coche and Balarin (1982) and Balarin (1985a).

4.2 Factors influencing yield

The Lake Victoria fishery has been the subject of a detailed study by Coche and Balarin (1982), Zonneveld (1983) and Reynolds and Greboval (1988). Results indicate conflicting statistics.

It would appear that the recent increase in *Lates niloticus* stocks have defied all forms of yield evaluations, as reflected by the 1982 catch of 61 000 t.

Of interest is the fact that smaller species (such as *Haplochromis*), liable to be consumed as prey, have almost disappeared from the landings (Coche and Balarin, 1982; see Tables 5 and 6 under "Lake Victoria" entry). It is suspected that stocks are being overfished. Concern over this has led the Fisheries Department to initiate a restocking programme; tilapias have been chosen as the most favoured candidate.

Lake Turkana, also reviewed in Coche and Balarin (1982), was the subject of a NORAD symposium (1983). Concern has been expressed over the downward trend in this fishery: down 57% in 1986 from a peak catch in 1976. Overfishing due to the limited mobility of fishermen, fishing of breeding grounds, climatic influences, and a change in fishermen structure have been implicated as reasons for drop in catches. A research programme to study the change, to restock the lake, and to initiate a deep-water fishery are to be assisted by NORAD. The originally estimated yields of 50 000-160 000 t/yr are now considered excessive; 20 000 t/yr is likely to be a more acceptable level.

The other lakes in Kenya are minor. Development of hydroelectric and irrigation schemes, especially along the Tana River, is likely to raise the fishery resources - but not to any significant level. Likely potentials are indicated in Table 1.

4.3 Future development possibilities

The estimates of maximum sustainable yields of Kenya's 10 000 km^2 of inland waters and 6 500 km^2 of fishable offshore waters generally lie between 81 000 and 305 000 t/yr, although estimates as low as 45 000 t/yr have also been advanced. The generally accepted estimate lies between 140 000 and 150 000 t/yr, split almost equally between freshwater and marine resources (Coche and Balarin, 1982). More recent estimates, however, suggest that marine reserves are considerably lower and the total likely yield may well be below 100 000 t/yr. If this should be the case, freshwater resources are fully exploited and there is small scope for expansion in the marine sector.

5. KEY BIBLIOGRAPHY

General: Balarin, 1985a
Lake Victoria: Reynolds & Greboval, 1988
Rift Valley Lakes: Burgis & Mavuti, 1987

6. WATER BODIES DIRECTORY

Lakes

Amboseli
Baringo
Bogoria (= Hannington)
Chala
Elementeita
Jipe
Kabongo
Kanyaboli
Kwenia
Logipi (Namakat)
Magadi
Naivasha
Nakuru
Natron
Ol Bolossat
Turkana (Rudolf)
Victoria

Rivers and swamps

Ewaso Ngiro
Ganale Dorya/Juba
Migori
Nzoia
Sabaki (Galana, Athi)
Tana
Turkwel
Lorian Swamp

Reservoirs

Aruba
Gtaru
Kamburu
Kindaruma
Lessos
Masinga
Sasumua
Wanjii

LAKE AMBOSELI

(International water)

Geographical data

Location: Kenya, Tanzania - 2° 32'-43'S; 37° 1'-14'E

Altitude: 1 140 m

Surface area: 189 km^2 (max); (Kenya: 177 km^2; Tanzania: 12 km^2)

Max. length: 30 km

Max. width: 9 km

Major inflowing river: Namanga

Special features: Lake Amboseli is a seasonal water body.

LAKE BARINGO

Geographical data

Location: Kenya - 0° 40'N; 36° 05'E

Altitude: 965 m

Surface area: 130 km^2

Depth: 5.6 m (mean); 7.5 (max.)

Volume: 0.7 km^3

Max. length: 21 km

Max. width: 11 km

Major inflowing rivers: Molo, Tangulbei

Physical and chemical data

pH: 8.7-8.9

Conductivity: K_{20} 416 µS/cm (Talling & Talling, 1965)

Ionic composition:

	(Beadle, 1932) mg/l	(Talling & Talling, 1965) mg/l
Na	126.0	95
K	15.0	13
Ca	22.0	11.5
Mg	2.0	3.15
HCO_3+CO_3	341.6	347.7
SO_4	40.0	19.0
SiO_2	-	23.5
PO_4-P	545 µg/l	-

Fisheries data

Fish species: (Lincer, *et al.*, 1981)

main catches: *Oreochromis niloticus*
Barbus gregori
Clarias mossambicus
Labeo cylindricus

Total annual catch and effort:
(Source: Statistical Bulletin, Fisheries Dept, Govt. of Kenya)

Year	Total catch (t)	No.of fishermen	No.of boats
1964	600	-	-
1965*	600	-	-
1967	518	-	-
1968	554	100	10
1969	503	120	33
1975	240	-	-
1976	257	-	-
1977	246	-	-

LAKE BARINGO (cont.)

Fisheries data (cont.)

Year	Total catch (t)	No.of fishermen	No.of boats
1978	315	-	-
1979	326	-	-
1980	411	-	-
1981	467	-	-
1982	401	102	12
1983	352	-	-
1984	297	-	-
1985	317	40	9
1986	152	68	23

* (FAO/UNDP, 1966)

Potential annual yield:
2 500-3 500 t (FAO/UNDP, 1966)
1 500 t (Govt. of Kenya, 1979b)
900 t (Welcomme, 1979a)

LAKE BOGORIA (= HANNINGTON)

Geographic data
Location: Kenya, 0° 15'N; 36° 06'E
Altitude: 975 m
Surface area: 34 km^2
Max. length: 17 km
Max. width: 4 km
Max. depth: 8.5 m (Tuite, 1981)
Special features: High alkalinity, closed basin.
Hot springs, geysers and fumaroles along lakeshore.

Physical and chemical data
Temperature: 24° C
pH: 9.8-10.3 (Tuite, 1981)
Conductivity: 72 000 μS/cm (Melack, 1976)
35 700 - 80 000 μS/cm (Tuite, 1981)
Ionic composition: (Beadle, 1932)

	mg/l
Na	14 360
K	304
Ca	26
SO_4	204
Cl	3 450
Alkalinity (HCO_3)	35 300

Fisheries data: There are no fish in Lake Bogoria (Burgis & Mavuti, 1987).

LAKE CHALA

(International water)

Geographical data

Location:	Kenya, Tanzania - 3° 19'S; 37° 42'E
Surface area:	5.2 km^2 (Kenya: 2.6 km^2; Tanzania: 2.6 km^2)
Max. length:	4 km
Max. width:	3 km

Fisheries data

Total annual catch and effort:

(Source: Statistical Bulletin, Fisheries Dept., Govt. of Kenya)

Year	Total catch (t)	No.of fishermen	No.of boats
1982	90	-	-
1983	10	-	-
1984	2	-	-
1985	2	50*	10*
1986	1	50*	10*

* including Lake Jipe

LAKE ELEMENTEITA

Geographical data

Location:	Kenya - 0° 26'S; 36° 05'E
Altitude:	1 829 m
Surface area:	20.7 km^2
Max. length:	8 km
Max. width:	4 km
Max. depth:	1.9 m
Special features:	High alkalinity; no outflow (closed basin).

Physical and chemical data

pH:	9.4 (Melack & Kilham, 1974)
Alkalinity:	1982 mg/l (Melack & Kilham, 1974)
Conductivity:	43 800 μs/cm (Talling & Talling, 1965) 15 000-40 200 μs/cm (Melack, 1976)

Ionic composition: (Melack & Kilham, 1974)

	mg/l
Na	3 795
K	274
Mg	0
Si	0
SO_4	177
Cl	38

Fisheries data: There are no fish in the lake (Burgis & Mavuti, 1987).

LAKE JIPE

(International water)

Geographical data

Location:	Kenya, Tanzania - 3° 35'S; 37° 85'E
Altitude:	700 m
Surface area:	39 km^2 (19.5 km^2 in Tanzania; 19.5 km^2 in Kenya)

LAKE JIPE (cont.)

Geographical data (cont.)
Max. length: 12 km
Max. width: 3 km
Major inflowing river: Lumi

Physical and chemical data (Kilham, 1971)
Total alkalinity: $CaCO_3$ 437 mg/l
Conductivity: K_{25} 618 μS/cm
Ionic composition:

	mg/l
Na	170.0
K	11.0
Ca	7.6
Mg	20.2
Cl	94.0
SO_4	8.0
SiO_2	46.0

Fisheries data
Total annual catch and effort (in Kenya)

Year	Total catch (t)	No.of fishermen	No.of boats	Source
1965	150	514	-	(a)
1982	409	-	-	(b)
1983	463	-	-	(b)
1984	396	-	-	(b)
1985	94	50*	10*	(b)
1986	128	50*	10*	(b)

* including Lake Chala
(a) Source: FAO/UNDP, 1966
(b) Source: Statistical Bulletin, Fisheries Dept., Govt. of Kenya

Potential annual yield:
100 t (Welcomme, 1979a)
300 t (FAO/UNDP, 1966)

LAKE KABONGO

Geographical data
Location: Kenya - 2° 7'S; 36° 25'E
Altitude: 1 066 m
Surface area: 3.2 km^2
Max. length: 4.5 km
Max. width: 1 km

LAKE KANYABOLI

Geographical data
Location: Kenya - 0° 4'N; 34° 10'E
Altitude: 1 189 m
Surface area: 10.5 km^2
Max. length: 5 km
Max. width: 3 km
Inflowing river: Yala

LAKE KWENIA

Geographical data

Location: Kenya - 1° 47'S; 36° 30'E

Altitude: 1 140 m

Surface area: 7 km^2

Max. length: 5 km

Max. width: 2 km

LAKE LOGIPI (NAMAKAT)

Geographical data

Location: Kenya - 2° 14'N; 36° 33'E

Surface area: 22.8 km^2

Max. length: 6.5 km

Max. width: 5 km

LAKE MAGADI

Geographical data

Location: Kenya - 1° 43'-2° 00'S; 36° 13'-36° 18'E

Altitude: The lake area is divided in two by a ridge to give a large southern element (Amagad) which lies at 660 m, and a smaller element (Little Magadi) which lies at 683 m.

Surface area: 108 km^2

Depth: 0.6 m (max) (Tuite, 1981)

Special features: (Burgis & Mavuti, 1987)
Lake Magadi only contains water after heavy rain and its alkaline sediments are commercially exploited for soda ash. It is the second largest expanse of solid trona (sodium carbonates and derivatives) in the world. It has almost no input of freshwater and is fed primarily by "boiling hot soda springs". It has no outlet.

Physical and chemical data

Conductivity: K_{20} 160 000 µS/cm (Talling & Talling, 1965)

Surface temperature: 28-43° C

pH: <10.5 (Coe, 1966)

Ionic composition: (Talling & Talling, 1965)

	mg/l
Na	38 000
K	537
Ca	<10
Mg	<30
HCO_3+CO_3	7 980
Cl	22 600
CO_4	900
SiO_2	250
Total P	11 000 µg/l

Fisheries data: The endemic cichlid *Oreochromis alcalicus grahami* (Coe, 1966) is confined to hot springs at the lake margins where they tolerate temperatures up to 40° C, salinities around 30^o/oo and pH of 10.5.

LAKE NAIVASHA

Geographic data

Location: Kenya - 0° 46'S; 36° 22'E
Altitude: 1 890 m asl
Surface area: 115-150 km^2
Max. length: 20 km
Max. width: 13 km
Depth: 17 m (max); 11 m (mean)
Seasonal fluctuation in level: 0.5 m
Major inflowing river: Melawa
Special features: Closed basin, but fresh water (Burgis & Mavuti, 1987)

Physical and chemical data

Conductivity: K_{20} 318-400 µS/cm (Talling & Talling, 1965)
pH: 8.8 (Talling & Talling, 1965)
9.0 (Beadle, 1932)
Ionic composition: (Talling & Talling, 1965)

	mg/l		mg/l
Na	41-45	Cl	14.4-16
K	21.6-22.6	SO_4	2
Ca	15.2-21.9	SiO_2	31.5-32.5
Mg	6.9-7.7	$NO_2.N$	32
HCO_3+CO_3	190.9-209.2	Total P	58-122

Fisheries data

Fish species: indigenous: *Aplocheilichthys antinorii*
introduced: *Oreochromis niloticus* (main catches); *O. spilurus niger*; *O. leucostictus*; *Tilapia zillii*; *Micropterus salmoides* (Burgis & Mavuti, 1987)

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats	Source
1964	550	-	-	-
1965	55	-	-	(a)
1967	955	-	-	(b)
1968	885	90	16	(b)
1969	929	130	16	(b)
1974	-	-	-	
1975	44	-	-	(b)
1976	78	-	-	(b)
1977	71	16	-	(b)
1978	255	-	-	(b)
1979	483	-	-	(b)
1980	477	-	-	(b)
1981	269	-	-	(b)
1982	411	80	70	(b)
1983	692	-	-	(b)
1984	320	-	-	(b)
1985	245	315	104	(b)
1986	576	268	67	(b)

(a) FAO/UNDP, 1966
(b) Statistical Bulletin, Fisheries Dept., Govt. of Kenya

Potential annual yield: 1 000 t (Welcomme, 1979a)
3 000-4 000 t (FAO/UNDP, 1966)

LAKE NAKURU

Geographic data
Location: Kenya - 0° 22'S; 36° 5'E
Altitude: 1 829 m
Surface area: 52 km^2
Max. length: 10 km
Max. width: 6 km
Depth: 0.56 to 4.5 m (max.)
Major inflowing rivers: Njoro, Nderit
Outflow: None
Special features: Highly alkaline

Physical and chemical data (cited in Burgis & Mavuti, 1987)
Temperature: surface: 25-27° C (mean); bottom: 20-21° C
pH: 10.5
Conductivity: extremely variable: 165 000 µS/cm (1961) to 9 500 µS/cm (1976)
Alkalinity: 5 000-90 000 mg/l
Ionic composition: (Hecky & Kilham, 1973)

	mg/l		mg/l
Na	3 300	K	237
Mg	0.9	Cl	1 020
SO_4	62	SiO_2	208
Alkalinity	121 meq/l		

Fisheries data (Burgis & Mavuti, 1987)
Fish species: No fish until the lake was successfully stocked with *Oreochromis alcalicus grahamii* in 1953, 1959, and again in 1962. See Vareschi (1979, 1982) and Vareschi & Jacobs (1984) for extensive analysis of the biomass, distribution, consumption and role in the ecosystem of this species and for the ecology of Lake Nakuru.

LAKE NATRON

(International water)

Geographic location
Location: Kenya, Tanzania - 2° 10'-2° 35'S; 36° E
Altitude: 610 m (Tuite, 1981)
Surface area: 900 km^2 (Tuite, 1981)
Max. length: 50 km
Max. width: 25 km
Depth: 0.5 m (max) (Tuite, 1981)
Special features: Highly alkaline; no outflow

Physical and chemical data
Ionic composition: (Guest & Stevens, 1951)

	mg/l		mg/l
K	3 000	SO_4	3 100
HCO_3+CO_3	158 600	SiO_2	850
PO_4-P	29 000 µg/l	Cl	65 000
Alkalinity	2 600 meq/l		

Fisheries data
Fish species: One endemic fish species: *Oreochromis alcalicus* (Coe, 1969)

LAKE OL BOLOSSAT

Geographic data
Location: Kenya

LAKE TURKANA (RUDOLF)
(International water)

Geographic data (see Figure 2)

Location: Ethiopia, Kenya - 2° 25'-4° 35'N; 35° 50'-36° 45'E

Altitude: 406 m

Surface area: 7 570 km^2

Max. length: 240 km

Max. width: 44 km

Depth: 73 m (max); 29.7 m (mean)

Volume: 224.75 km^3

Shoreline: 917 km

Major inflowing rivers: Omo, Suam-Turkwell

Physical and chemical data

Temperature: 27.0-28.9° C (surface)

pH: 9.3-9.7

Conductivity: 2 860 µS/cm (Beadle, 1932);
K_{20} 3 300 µS/cm (Talling & Talling, 1985)

Ionic composition: (Beadle, 1932) (Talling & Talling, 1965)

	mg/l	mg/l
Na	770	810
K	23	21
Ca	5	5.7
Mg	4	3
HCO_3+CO_3	1 323.7	1 494.5
Cl	429	475
SO_4	56	64
SiO_2	4.2	18
Total P		2 600 µg/l

Fisheries data

No. of fish species: 37 (Greenwood, 1964)

Total annual catch and effort: (in Kenya)

Year	Total catch (t)	No.of fishermen	No.of boats
1964	850	-	-
1965-66	-	-	-
1967	1 727	-	-
1968	2 044	1 200	30
1969	3 753	2 655	125
1970	4 000	-	-
1975	4 236	-	-
1976	17 044	-	-
1977	15 473	-	-
1978	15 560	-	-
1979	13 731	-	-
1980	12 384	-	-
1981	10 529	-	-
1982	11 040	846	282
1983	10 113	-	-
1984	8 448	-	-
1985	7 460	785	261
1986	7 324	783	261

Source: 1967-1986: Stat. Bull.,
Fisheries Dept., Govt. of Kenya

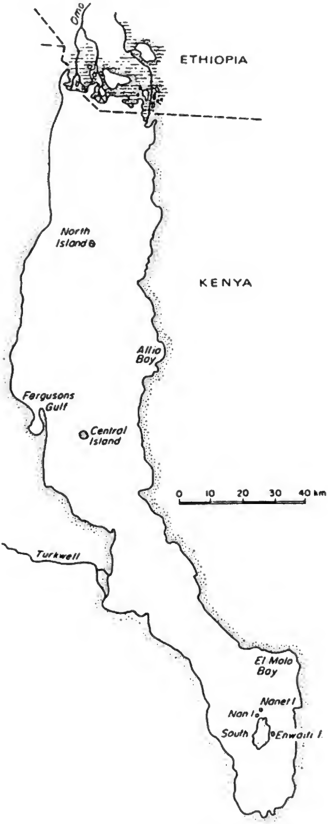


Fig. 2. LAKE RUDOLF - TURKANA
(Welcomme, 1972)

LAKE TURKANA (cont.)

Fisheries data (cont.)
Potential annual yield:
20 000 t (Balarin, 1985a)
50 000-160 000 t (FAO/UNDP, 1966)
5 000-10 000 t (Lake Turkana Investigation Team, 1975)
Note: Overfishing of tilapia breeding grounds is suspected (Coche & Balarin, 1982)
Specific reference: NORAD, 1980, 1983a,b.

LAKE VICTORIA
(International water)

Geographic data (Welcomme, 1972)
Location: Kenya, Tanzania, Uganda (see Fig. 3)
0° 20'N-3° 0'S; 31° 39'-34° 54'E
Altitude: 1 136 m

Surface area:			
	Kenya	4 100 km^2	(6%)
	Tanzania	33 700 km^2	(49%)
	Uganda	31 000 km^2	(45%)
	Total	68 800 km^2	

Max. length: 400 km
Max. width: 240 km
Depth: 84 m (max); 40 m (mean)
Shoreline: 3 440 km
Catchment area: 263 000 km^2
Major inflowing rivers: Kagera, Nzoia, Yala
Outflowing river: Victoria Nile

Physical and chemical data
Temperature: Surface: 23-28° C
Dissolved solids: 97 mg/l
pH: Kavirondo Gulf: 8.2 (Talling & Talling, 1965)
9.0 (Graham, 1929)
Open lake: 8.0 (Talling & Talling, 1965)
8.5 (Graham, 1929)
Conductivity: K_{20} 91*-98** µS/cm (EAFRO, 1952*; 1953**)
Ionic composition:

	(EAFRO, 1952a) mg/l	(Talling & Talling, 1965) mg/l
Na	12.5-13.5	10.4
K	3.7-4.2	3.8
Ca	5.0-7.0	5.6
Mg	2.3-3.5	2.6
HCO_3+CO_3	61.0-67.1	54.9
Cl	-	3.9
SO_4	0.8	-
SiO_2	3-9	4.2
		µg/l
NO_3N	-	11
PO_4-P	-	13
Total P	-	47

Fisheries data
No. of fish species:
177, of which 127 are cichlids (Greenwood, 1964), mostly *Haplochromis* species.
Species introduced: in the 1950's:
Oreochromis niloticus, O. leucostictus, Tilapia zillii, T. rendalli;

LAKE VICTORIA (cont.)

Fisheries data (cont.)

Species introduced: in the late 1950's, early 1960's: *Lates niloticus*

- In the 1960's and 1970's, *Haplochromis* species constituted an estimated 80% of the Lake's fish biomass (FAO, 1973).
- In the late 1970's and the 1980's, the Nile Perch (*L.niloticus*) population increased extremely, to the detriment mainly of the *Haplochromis* population. (See Table 6, underlined.)
- From data provided by the Fisheries Depart. of the Govt. of Uganda, the relative importance of Nile Perch increased as follows (cited in TDRI, 1983):

Year	Nile Perch % of total catch	
1971	0.3	
1972	1.0	
1973	3.0	
1974	5.0	
1975	16.0	
1982/83	30.0	(TDRI, 1983 estimate)

It is anticipated that the Nile Perch population will decrease as the *Haplochromis* stocks become seriously depleted (TDRI, 1983).

Main catches: See Table 5 (Kenya) and Table 6 (total Lake)

Table 5. MAIN CATCHES (KENYA) - LAKE VICTORIA
(after Reynolds & Greboval, 1988)

Species	1975 (t)	1979 (t)	1985 (t)
O. esculentus	28	94	42
O. niloticus	202	962	7 573
Other tilapia	412	1 683	1 827
Bagrus	1 389	1 769	61
Lates	51	4 286	50 029
Protopterus	1 469	472	150
Haplochromis	4 620	6 599	6
Clarias	2 584	3 029	547
Barbus	283	417	113
Synodontis	126	482	0
Mormyrus	58	359	49
Labeo	108	443	0
Schilbe	54	320	5
Rastrineobola	4 548	9 321	25 866
Other small mixed	649	356	2 321
Total	16 581	30 592	88 589

Sources: CIFA, 1981; DFK Statistical Bulletins; Bwathondi, 1988.

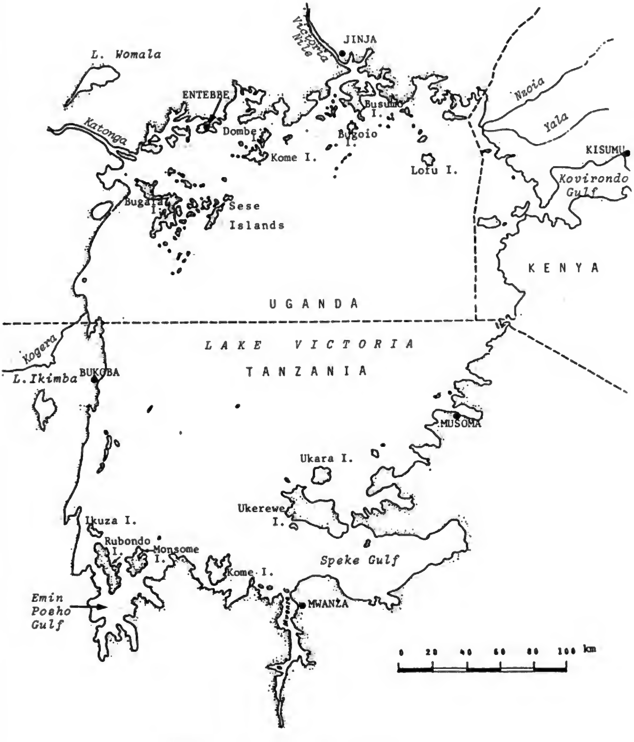


Fig. 3. LAKE VICTORIA
(Welcomme, 1972)

LAKE VICTORIA (cont.)

Fisheries data (cont.)

Table 6. TOTAL FISH PRODUCTION IN LAKE VICTORIA, 1975, 1979, 1985
(after Reynolds & Greboval, 1988)

Species	1975 (t)	(%)	1979 (t)	(%)	1985* (t)	(%)
O. esculentus	3 690	4.8	94	2.2		
O. niloticus	6 092	7.9	3 320	3.2	20 093	10.7
Other tilapia	3 509	4.6	6 355	6.0		
Bagrus	10 146	13.2	13 482	12.8	9 276	4.9
Lates	301	0.4	4 476	4.3	87 637	46.7
Protopterus	7 844	10.2	6 445	6.1	4 200	2.2
Haplochromis	22 458	29.2	29 909	28.4	11 578	6.2
Clarias	6 382	8.3	7 917	7.5	6 107	3.3
Barbus	775	1.0	1 141	1.1	515	0.3
Synodontis	2 491	3.2	7 356	7.0	9 278	4.9
Mormyrus	178	0.2	897	0.9	402	0.2
Labeo	1 719	2.2	7 332	7.0	544	0.3
Schilbe	1 069	1.4	1 958	1.9	1 582	0.8
Rastrineobola**	4 558	5.9	10 989	10.4	25 866	13.8
Other small mixed**	4 707	7.4	1 419	1.3	10 417	5.6
TOTAL	76 919		105 267		187 495	

Sources: CIFA, 1981; DFK Statistical Bulletins; Bwathondi, 1988.
* Figures for 1985 combine Kenya and Tanzania only.
** Tanzania combines "Rastrineobola" and "Other Small Mixed."

Total annual catch and effort: (in Kenya)

Year	Total catch (t)	No.of fishermen	No.of boats
1964	12 000	-	-
1965-66	-	-	-
1967	15 748	-	-
1968	16 357	6 000	4 000
1969	17 442	13 600	3 600
1970	16 400	-	-
1971	14 918	-	-
1972	15 989	-	-
1973	16 797	-	-
1974	16 258	-	-
1975	17 175	-	-
1976	18 680	-	-
1977	19 332	-	-
1978	23 856	-	-
1979	30 592	-	-
1980	26 914	-	-
1981	38 179	18 000	-
1982	60 958	-	-
1983	77 327	-	-
1984	71 854	-	-
1985	88 589	21 500	5 500
1986	103 163	21 000	5 000

Source: 1967-1986: Stat.Bull, Fisheries Dept., Govt. of Kenya

LAKE VICTORIA (cont.)

Fisheries data (cont.)
Potential annual yield: (in Kenya)
25 000 t (Welcomme, 1972)
28 000-40 000 t (FAO/UNDP, 1966)
30 000-45 000 t (Coche & Balarin, 1982)
10 000-26 000 t (Zonneveld, 1983)

EWASO NGIRO RIVER

Geographical data
Source: Mau Escarpment, Kenya
Altitude: 3 124 m
Total length: 200 km
Drainage area: 15 022 km^2
Countries traversed: Kenya
Major tributaries: Engare Siapei; Engare Narok
Discharges to: Lake Natron via Ngare Ngiro Swamp
Volume of discharge: 6.6-63.0 (mean: 22.4) m^3/sec; 0.74 km^3/yr
Flood regime: Bimodal peaks in flow in April and November

Fisheries data
Total annual catch: 300 t (1965) from Ewaso Ngiro River and Ngare Ngiro Swamp

GANALE DORYA/JUBA RIVER
(International water)

Geographical data
Source: Mendebo Mountains, Ethiopia - 6° 49'N; 38° 41'E
Total length: 1 600 km
Countries traversed: Ethiopia, Somalia, Kenya (Lagh Bor)
Major tributaries: Webbe Schibele, Lagh Bor
Discharges to: Indian Ocean, Somalia - 0° 14'S; 42° 32'E

MIGORI RIVER

Geographical data
Source: Soit Ololol Escarpment
Altitude: 1 981 m
Total length: 140 km
Countries traversed: Kenya
Major tributaries: Gucha
Discharges to: Lake Victoria - 0° 55'S; 34° 8'E
Volume of discharge: 0.87 km^3/yr
Special features: Two small dams/reservoirs on minor tributaries of Migori channel at 1° 13'S; 34° 34'E and at 1° 11'S; 34° 38'E

NZOIA RIVER

Geographical data

Source: Kenya, southeast slopes of Mt. Elgon, plateau areas of Transuzoia and Vasin Gisha, northern Nandi Hills and hills of the Kakamega and Bugowa districts.
Total length: 200 km
Drainage area: 13 000 km^2
Countries traversed: Kenya
Major tributaries: Kipkarren, Kisama
Discharges to: Lake Victoria (Kavirondo Gulf) through Yala Swamp
Volume of discharge at mouth: 30-395 m^3/sec (1.92 km^3/yr)
Special features: Receives sulfite pulp mill effluent

Physical and chemical data (Petr, 1977)

Ionic composition:

	mg/l
Na	8.7
K	3.5
Ca	1.2
Mg	11.3
HCO_3	83.0
Cl	1.4
SO_4	8.6

Fisheries data

Total annual catch: 1 000 t in 1959 (Whitehead, 1959a,b), but in recent years this fishery for migratory *Labeo victorianus* from Lake Victoria has collapsed.
No. of fish species: 28 (Petr & Paperna, 1979)
Note: Other reference: Balirwa & Bugenyi, 1980

SABAKI (GALANA, ATHI) RIVER

Geographical data

Source: Kenya (Kikuyu Escarpment)
Altitude: 1 870 m
Total length: 560 km
Countries traversed: Kenya
Major tributaries: Tsaro, Kiboko
Discharges to: Indian Ocean - 3° 9'S; 40° 8'E
Special features: A broad floodplain in its lower reaches, with several small lakes.

Fisheries data

Total annual catch: 300 t in 1960 (Whitehead, 1960)

TANA RIVER

Geographical data

Source: Aberdare Mountains, Kenya
Altitude: 3 999 m
Total length: 800 km
Drainage area: 42 217 km^2
Countries traversed: Kenya
Discharges to: Indian Ocean - 2° 32'S; 40° 31'E

TANA RIVER (cont.)

Geographical data (cont.)

Volume of discharge at mouth: 151 m^3/sec (mean)
Flood regime: Peak floods in November and in May
Special features: The upper course of the Tana River is impounded at four sites: Masinga, Kamburu, Gtaru and Kindaruma. There is a floodplain along the lower course with numerous small lakes, including Lakes Baliaa and Shakababo.

Fisheries data

Total annual catch: Tana river and reservoirs: 21 t in 1982; 433 t in 1985 (Statistical Bulletin, Fisheries Dept., Govt. of Kenya).

TURKWEL RIVER

(International water)

Geographical data

Source: Mt. Elgon (Bukwa tributary)
Altitude: 4 322 m
Total length: 340 km (300 km in Kenya)
Countries traversed: Kenya, Uganda
Major tributaries: Suam (Bukwa), Morun
Discharges to: Lake Turkana - 3° 3'N; 36° 8'E

LORIAN SWAMP

Geographical data

Location: Kenya - 0° 40'N; 39° 35'E
Surface area: 2 590 km^2
Inflowing rivers: northern Ewaso Ngiro (322 km long)
Outflowing river: Lak Dera

ARUBA RESERVOIR

Geographical data

Location: Kenya - 3° 22'S; 38° 47'E
Altitude: 436 m
Surface area: 0.81 km^2 (max); 0.40 km^2 (min)
Major inflowing river: Voi
Outflowing river: Voi

Fisheries data

Total annual catch: 20 t in 1965

GTARU RESERVOIR

Geographical data

Location: Kenya - 0° 47'S; 37° 44'E
Surface area: 3.1 km^2 (at USL)
Max. length: 7 km
Major inflowing river: Tana (outflow from Kamburu Reservoir)
Outflowing river: Tana
Volume: 20 x 10^6 m^3 at USL
Depth: 6.5 m (mean at USL)

KAMBURU RESERVOIR

Geographical data

Location: Kenya - 0° 49'S; 37° 40'E
Altitude: 1 006 m USL
Dam height: 56 m (1 010 m asl)
Date closed: March 1974
Surface area: 15 km^2 (max); 2.2 km^2 (min)
Max. length: 11 km
Depth: 53 m (max); 10.4 m (mean) at USL
Volume: 156 x 10^6 m^3 at USL
Annual fluctuation in level: 16 m
Major inflowing rivers: Tana (outflow from Masinga Reservoir), Thiba

Physical and chemical data

Surface temperature: 22-27° C
pH: 4.0
Conductivity: K_{25} 40 µS/cm
Ionic composition:

	mg/l
Na	4.8-12.5
K	1.4-5.6
Ca	6.9-12.2
Mg	2.7-4.8
HCO_3	39.0-73.0
CO_3	nil-5.0
Cl	3.3-9.0
SO_4	1.0-11.0
SiO_2	10.0-20.0
Fe	0.19-11.7
Mn	nil-0.8
NO_2-N	nil-0.2
NO_3-N	nil-1.4

Fisheries data

No. of fish species: 10
No. of fishermen: 13 (1974-79)

KINDARUMA RESERVOIR

Geographical data

Location: Kenya - 0° 49'S; 37° 47'E
Altitude: 780.29 m USL
Dam height: 25 m (782.57 m asl)
Date closed: 1968
Surface area: 14.7 km^2
Depth: 22.7 m (max)
Volume: 16 x 10^6 m^3 at USL
Max. length: 7 km
Max. width: 3 km
Major inflowing river: Tana (outflow from Gtaru Reservoir)
Outflowing river: Tana

LESSOS RESERVOIR

Geographical data
Location: Kenya - 0° 17'N; 35° 20'E
Surface area: 2.1 km^2
Max. length: 2 km
Max. width: 1.5 km

Fisheries data
Total annual catch: 50 t in 1965

MASINGA RESERVOIR

Geographical data
Location: Kenya - 0° 54'S; 37° 30'E
Date closed: 1982
Volume: 1 560 km^3
Surface area: 120 km^2 at USL
Depth: 13 m (mean at USL)
Max. length: 37 km
Max. width: 13 km
Major inflowing rivers: Tana, Thika
Outflowing river: Tana

Fisheries data
Potential annual yield: 480 t (Balarin, 1985)

SASUMUA RESERVOIR

Geographical data
Location: Kenya

WANJII RESERVOIR

Geographical data
Location: Kenya

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LESOTHO

1. GEOGRAPHY AND CLIMATE

Lesotho (with a surface area of 30 350 km^2) is primarily a highland plateau (headwaters of the Orange (= Senqu) River) with some lowlands in the south.

Lowland temperatures are generally high while upland regions are cool. Rainfall is moderate and droughts are common.

The economy is mainly subsistence in nature, based on livestock and farming. Soil erosion is severe, especially in the eastern uplands.

2. HYDROGRAPHY (after Chondoma, 1988a)

2.1 **Lakes:** There are no natural lakes.

2.2 Rivers, Floodplains and Swamps

All rivers in Lesotho belong to the Orange River system. There are three river systems: the Senqu, Makhaleng and Caledon (Fig. 1).

The Senqu River system, which is the largest, starts north of Cathedral Dome Peak at an altitude of 3 050 m and runs south. When flowing out of Lesotho into Orange Free State at the southwestern border of Lesotho, the Senqu River has a catchment area of about 2 100 000 ha and an average flow rate of 100 m^3/s.

The Makhaleng, which starts in the Maluti ranges, runs south through the middle of the country. It joins the Senqu at the point where the Senqu leaves Lesotho into Orange Free State. At this point Makhaleng River has a catchment area of about 300 000 ha and an average flow of about 15 m^3/s. The total length of Senqu and Makhaleng and their main tributaries in Lesotho is over 1 600 km.

The Caledon River forms the western border of Lesotho and drains the lowland part of the country. At the point where the Caledon flows into the Orange Free State it has an average flow rate of about 36 m^3/s and a catchment area of about 1 300 000 ha, of which 700 000 ha are in Lesotho and 600 000 ha are in South Africa. The total length of the Caledon and its main tributaries in Lesotho is about 560 km.

The flow rates of the rivers fluctuates considerably between and within years, depending on the rainfall. It is common for the Caledon to run dry in dry years. Table 1 gives the catchment areas and mean annual runoff (MAR) of the three major river systems.

The rivers in Lesotho are in the upper reaches of the mountain zone where the flow is swift and there are no floodplains.

2.3 Reservoirs

There are a number of medium- and small-sized reservoirs which were constructed for water and soil conservation purposes. A small number of these reservoirs have been washed away and a fair number have silted up. There is no up-to-date information on the condition of the reservoirs in the country. However,

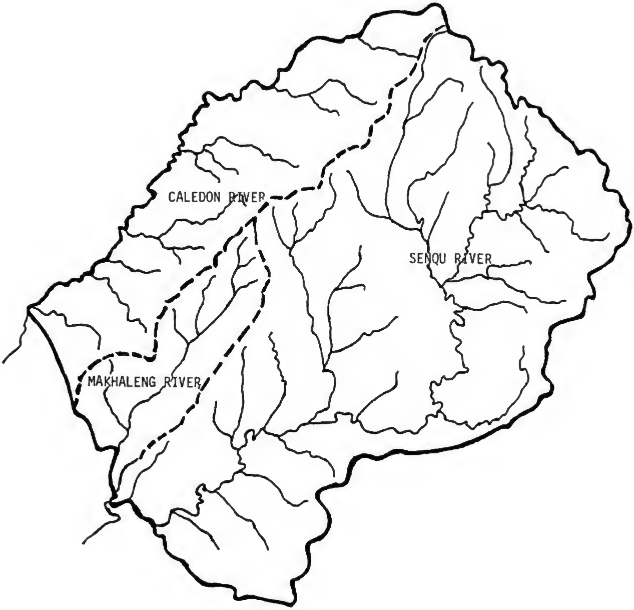

Fig. 1. LESOTHO RIVER SYSTEMS AND THEIR CATCHMENTS
(SWECO, 1975)

Table 1. TOTAL SURFACE WATER RESOURCES OF LESOTHO BY CATCHMENT

Catchment	Catchment area km^2	Mean annual runoff (MAR) estimates* m^3/s			
		1967	1969	1971	1975
Senqu at Makhaleng confluence	20 714	91.9	101.6	91.9	99
Makhaleng at Senqu confluence	3 044	17	14.2	14.2	14.2
Caledon at border	6 694	-	24.1	24.1	27.5
Area between Caledon and Makhaleng	260	-	-	-	0.6
Total	30 712	-	139.9	130.2	141.2

* Sources: see Chondoma, 1988a

a preliminary survey by Fisheries Section in the lowlands has revealed that over 100 ha of small reservoirs could be used for intensive aquaculture with minor improvements; another 50-100 ha of medium-sized reservoirs could be developed for capture fishery and cage culture.

The Lesotho Highland Water Project plans to build 4 dams which will develop the highland water resources of the Senqu River for hydroelectricity generation, irrigation, fisheries and water for sale to South Africa. No estimates are available on the surface area of the dams after flooding, but other statistics of the dams to be constructed have been published (LHWP, 1986). The dams will be constructed in three phases, with the first phase expected to start in 1988 and the completion of the final phase planned for 2025.

2.4 Coastal Lagoons

None; Lesotho is landlocked.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

Annual average fish production in Lesotho is about 20 tons. In good production years yields as high as 30 tons have been realized. However, during the recent severe drought experienced in the region, stocked pond area fell from 20 ha to 8.0 ha and fish production fell to 8.8 tons in 1985 (Fisheries Section, Ministry of Agriculture) (see Table 2; updated estimates are given in Table 3).

Table 2. STOCKED POND AREA - Lesotho, 1979-1985
(after Chondoma, 1988a)

Year	Number of ponds in production	Total pond area (ha)
1979	73	16.04
1980	67	15.77
1981	29	5.50
1982	63	13.77
1983	102	22.55
1984	51	11.40
1985	45	8.99

Fish species currently cultured in Lesotho fall into two main categories:
indigenous: *Clarias gariepinus*;
introduced: *Cyprinus carpio, Hypophthalmichthys molitrix, Salmo gairdneri, Ctenopharyngodon idella*.

Aquaculture production by species from 1982 to 1987 is given below (Vincke, pers.comm., 1989).

Species	1982	1983	1984	1985	1986	1987
Cyprinus carpio	27	17	11	9	20	23
Salmo gairdneri	-	-	1	2	2	1
Clarias gariepinus	2	1	1	-	3	2
Total	29	18	13	11	25	26

In light of the recent drought the water security situation, and land use trends, an area of 500 ha of intensive commercial fish farms, with current production levels of 1 000-1 500 kg/ha, Chondoma (1988a) estimates potential annual yields of 500-750 tons.

3.2 Fish production and per caput supply

Table 3. FISH PRODUCTION AND PER CAPUT SUPPLY - Lesotho, 1970-1987

		Nominal Domestic Production (excluding exports) (t) [2]			Nominal Consumer Supply (exluding imports and exports (kg/person)		
Year	Population '000 [1]	Inland capture	Aqua-culture [3]	Total	Inland capture	Aqua-culture [3]	Total
1970	1 064	- [3]	0	0 [2]	-	0	0
1971	1 088	-	0	0 [2]	-	0	0
1972	1 112	-	0	0 [2]	-	0	0
1973	1 137	-	0	0 [2]	-	0	0
1974	1 162	-	10	10 [2]	-	0.008	0.008
1975	1 187	-	23	23 [2]	-	0.02	0.02
1976	1 215	-	27	27 [2]	-	0.02	0.02
1977	1 244	-	22	22 [2]	-	0.02	0.02
1978	1 275	-	24	24 [2]	-	0.02	0.02
1979	1 306	-	27	27 [2]	-	0.02	0.02
1980	1 339	-	23	23 [2]	-	0.02	0.02
1981	1 373	-	15	15 [2]	-	0.01	0.01
1982	1 408	2 [4]	29 [5]	31	0.001	0.02	0.02
1983	1 444	-	18 [5]	18	-	0.01	0.01
1984	1 481	-	13 [5]	13	-	0.01	0.01
1985	1 520	-	11 [5]	11	-	0.01	0.01
1986	1 560	-	25 [5]	25	-	0.02	0.02
1987	1 601	-	26 [5]	26	-	0.02	0.02

[1] Source: FAO
[2] Source: FAO Fisheries Department FISHDAB
[3] - = data not available
[4] SADCC, 1984
[5] Vincke, 1989 (pers.comm.)

3.3 Inland catch range and potential yield

Table 4. INLAND CATCH RANGE AND POTENTIAL YIELD

Water body	Period	Annual catch range (t)	Potential annual yield (t)
Senqu River	1982	2	-
Makhaleng River	-	-	-
Caledon River	-	-	-
Total Rivers	current	1-2	120
Reservoirs	-	-	-
Aquaculture	1974-1987	10-30	500-750

(Sources: see text)

Total annual yield:
Fishery: 2 t in 1982 (SADCC, 1984)
Aquaculture: 10-30 t (average: 20 t)

Potential annual yield:
Fishery: 120 t (Maar, 1965)
Aquaculture: 500-750 t (Chondoma, 1988a)
Total inland: 290 t (SADCC, 1984)
620-870 t (Maar, 1965; Chondoma, 1988a)

4. STATE OF THE FISHERY (adapted from Chondoma, 1988a)

4.1 Yield

The diversity of fish species in Lesotho is very limited; only 9 indigenous species in 5 genera occur. There are 8 introduced species, 5 of which have acclimatized well in the rivers and reservoirs; 2 are exclusively used in ponds for aquaculture.

There is no capture fishery of any significance in Lesotho. The only existing capture fishery is the sport fishery, mainly for trout and yellowfish in the mountain streams and bass in the lowland reservoirs. There is, however, a seasonal interest in catching yellowfish during the spawning migrations upstream, when they are caught by shepherds using very primitive gear such as stones, sharp sticks and stone traps.

The current estimated catch from the rivers is between 1 and 2 tons, mainly of trout and yellowfish.

The only significant fish production comes from aquaculture (see section 3.1).

4.2 Factors influencing yield

Unpredictable rainfall in dry years may cause the drying up of rivers, reservoirs and ponds. Cool temperatures also slow down growth rates and therefore production. Constraints on aquaculture include low market value of fish and high feed costs.

4.3 Future development possibilities

Information on potential fish production is not available. The only estimate is that done by Maar (1965), which gives riverine annual production from indigenous stocks as 100 tons and 20 tons from trout, if the rivers are regularly restocked with trout fingerlings.

At the 1983 production level of 18 tons and an import of 1 030 tons, an annual increase in production of over 1 000 tons is needed to substitute the imported fish. It is recognized that, at the present rate of aquaculture development and potential (500-750 t) and riverine fishery potential (120 t), Lesotho is unlikely to meet its national fish production requirement in the near future. The greatest potential for fisheries development in Lesotho lies in the realization of the Lesotho Highland Water Project, scheduled to start in 1988 and to be completed in 2025.

5. KEY BIBLIOGRAPHY

Chondoma, 1988a

6. WATER BODIES DIRECTORY

Rivers

Orange (= Senqu)

Reservoirs

Scott
Zacholo

ORANGE RIVER (= SENQU RIVER)

(International water)

Geographical data (Welcomme, 1972)

Source:	Lesotho, Drakensberg Mountains
Altitude:	3 300 m
Total length:	2 160 m
Drainage area:	640 000 km^2
Countries traversed:	Lesotho, Namibia, South Africa
Major tributaries:	Vaal River (1 200 km)
Discharges to:	South Atlantic
Flood regime:	floods between November and March

Physical and chemical data

Conductivity:	K_{25} 159 μS/cm (mean) (Keulder, 1970)
pH:	in upland tributaries of Lesotho, between 6.0 and 7.0

SCOTT RESERVOIR

Geographical data
Location: Lesotho

ZACHOLO RESERVOIR

Geographical data
Location: Lesotho

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MADAGASCAR

1. GEOGRAPHY AND CLIMATE (after Welcomme, 1979a)

The country consists of the main Island of Madagascar and some smaller offshore islands. Total surface area is 581 540 km^2. The main island consists of a central high plateau between 1 000 and 2 000 m in altitude which falls away steeply on all sides to a narrow coastal belt.

The central islands have a temperate climate with a single rainy season from November to April. The coastal regions have a tropical climate. On the north and west coast rains are light, whereas on the south and east rains are heavy and continuous throughout the year.

The country is wholly agricultural and bad land-use practices and deforestation have resulted in severe erosion problems which have led to many of the rivers being heavily charged with silt.

2. HYDROGRAPHY (see Fig. 1)

2.1 Lakes

There are hundreds of small and medium-sized lakes. Many are associated with the floodplains of westward flowing rivers. There are also many small mountain and crater lakes. Totalling the lakes, reservoirs and coastal lagoons, there are some 530 lacustrine water bodies with surface areas over 0.20 km^2 in Madagascar.

The ten largest lakes are:

	(km^2)
Alaotra	200
Kinkony	139
Ihotry	94.2
Itasy	35
Tsimanampetsotsa (saline)	29.88
Komanaomby	18.1
Bemamba	15.9
Hima	15.5
Mandrozo	14.4
Amparihibe-South	12.5

The total lake area in Madagascar is probably over 600 km^2.

2.2 Rivers, Floodplains and Swamps

Many rivers flow from the central highlands of Madagascar. The largest river basins drain to the west and floodplains are developed along the lower courses. Total floodplain area has been estimated at 918 km^2 but the actual area may be greater than 2 000 km^2. Swamps are associated with some lakes (i.e., Lake Alaotra).

2.3 Reservoirs

Two medium-sized reservoirs (Mantasoa and Tsiazompaniry) with surface areas of 18.0 and 31.0 km^2, respectively, are situated near the capital (Tananarivo).

There are also several small reservoirs:

	(km^2)
Ivakoana	2.88
Sahamaloto	2.80
Ambilivily	2.35
Antanifotsy	1.99
Maromandia	1.99
Maroala	1.44
Andekaleka, Ivendrano and Mandraka	

2.4 Coastal Lagoons

Madagascar has significant brackishwater resources. These consist of lagoons on the east coast and mangrove swamps grouped around the mouths of the main rivers on the west coast.

Main Lagoons	(km^2)
Loza	156
Pangalanes (East Complex)	180
Anony	22.6
Ampahana	21.8
Masianaha	13.3
Total	393.7

Main Mangrove Swamps	
Mahavary-Nord	332
Loza and Marinda	180
Mahajamba	394
Betsiboka	460
Mahavavy-Sud	340
Besalampy	457
Maintirano	255
Tsiribihira	370
Mangoky	232
Total	3 020

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

The number of ponds in existence in Madagascar since 1938 are shown below:

Year	Ponds
1938	800-1 100
1939-45	-
1946	1 100
1947-52	-
1953	1 500
1954	2 000
1955	3 000
1956	23 300
1957	42 000
1958	62 500
1969	75 000
1960	72 000
1961	75 600
1962	85 000
1963	82 450
1964	79 150

Year	Ponds
1965	72 820
1966	65 530
1967	58 980
1968	49 332
1969	50 856
1970	42 375

In 1982 fishponds totalled about 1 000 ha in area. In addition, about 250 km^2 of rice fields were used for rice-cum-fish culture.

In 1985, the number of ponds had already decreased to about 6 000, with an estimated production of 284 t, mainly common carp and tilapias. Production of aquaculture by species is shown below:

Species	1982	1983	1984	1985	1986	1987
Cyprinus carpio	300	180	186	210	145	156
tilapias (*Oreochromis* spp.)	-	-	4	74	36	38
Salmo gairdneri	-	-	-	0.3	0.1	-
Total	300	180	190	284	181	194

Source: Vincke, 1989 (pers.comm.)

3.2 Fish Production and per caput supply

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Madagascar, 1970-1987

		Nominal Production (including exports) (t) 2/				Nominal Consumer Supply (including exports) (kg/person)			
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Marine capture 6/	Total	Inland capture	Aqua-culture 3/	Marine capture	Total
1970	6 716	35 100	- 4/	13 100	48 200	5.2	-	1.9	7.1
1971	6 885	36 900	-	13 800	50 700	5.4	-	2.0	7.4
1972	7 058	37 600	-	14 200	51 800	5.3	-	2.0	7.3
1973	7 236	39 100	-	21 200	60 300	5.4	-	2.9	8.3
1974	7 417	40 300	-	25 400	65 700	5.4	-	3.4	8.8
1975	7 604	41 500	-	14 500	56 000	5.4	-	1.9	7.3
1976	7 806	41 500	-	13 450	54 950	5.3	-	1.7	7.0
1977	8 018	41 500	-	14 540	56 040	5.2	-	1.8	7.0
1978	8 239	41 500	-	12 880	54 380	5.0	-	1.6	6.6
1979	8 468	41 500	-	11 875	53 375	4.9	-	1.4	6.3
1980	8 704	37 964	-	12 188	50 152	4.4	-	1.4	5.8
1981	8 948	38 500	-	11 675	50 175	4.3	-	1.3	5.6
1982	9 200	38 700	300 5/	10 335	49 335	4.2	0.03	1.1	5.3
1983	9 461	42 020	180 5/	12 558	54 758	4.4	0.02	1.3	5.7
1984	9 731	42 310	190 5/	13 463	55 963	4.3	0.02	1.4	5.7
1985	10 012	45 716	284 5/	17 589	63 589	4.6	0.03	1.7	6.3
1986	10 307	45 819	181 5/	17 589	63 589	4.4	0.02	1.7	6.1
1987	10 610	45 806	194 5/	17 589	63 589	4.3	0.02	1.7	6.0

1/ Source: FAO

2/ Source: FAO Fisheries Department FISHDAB

3/ included in "Inland capture" if not specified

4/ - = data not available

5/ Vincke, 1989 (pers.comm.)

6/ From 1980 to 1983, marine exports were as follows:
3 429 t (1980); 3 237 t (1981); 3 989 t (1982); 3 120 t (1983).

3.3 Inland catch range and potential yield

Table 2. INLAND CATCH RANGE AND POTENTIAL YIELD

Water body	Period	Annual catch range (t)	Potential annual yield (t)
Lakes			
Alaotra	1960-71;1974	2 250-4 000	-
Itasy	1960-71;1975	273-1 400	-
Kinkony	1960-71;1975	620-826	-
No information available for Lakes Anosy, Antsohaly-Fenoarivo, Bemamba, Ihotry, Mahazoarivo, Mandrozo, Namonty			
Rivers			
Betsiboka/Floodplain	1960-71	1 800-2 600	-
No information available for Rivers Sofia, Tsiribihina			
Reservoirs			
Mantasoa	1960;1964-71;1975	6-60	-
Tsiazompaniry	1962;1965-71;1975	1-60	-
No information available for Reservoirs Ambilivily, Antanifotsy, Ivakoana, Maroala, Maromandia, Sahamaloto			
Lagoons			
Pangalanes-East Lagoon Complex	1960-71;1975	320-398	-
No information available for Lagoons Ampahana, Anony, Loza, Masianaka			

Total annual yield: 5 300-9 300 t (partial total, Table 2)
40 000-45 000 t (current: 1983-1987) (see Table 1)

Potential annual yield:
77 000 t fresh and brackishwater fish catches
(Rabelahatra, 1988)

4. STATE OF THE FISHERY

4.1 Yield (mainly after Rabelahatra, 1988)

Inland fisheries take place mainly in lakes and lagoons; the rivers are less exploited. Among the most important lakes and lagoons, seven are heavily exploited (22 500 t for 630 km^2 in 1984 = 357 kg/ha). Two lakes (Alaotra and Itasy) are already overfished.

In 1984 there were 17 740 fishermen specialized in inland fisheries. About 70% of the catches are thought to be self-consumed by the fishermen's relatives and by the local farmers.

The current production from aquaculture (200-300 t/yr) can be substantially increased through training and better manangement. Production from 1982 to 1987, by species, is given in section 3.1.

4.2 Factors influencing yield

The fishery has been developing at about 2% per year over the last 15 years. In some lakes (i.e., Lake Alaotra), accelerated fishery development occurred when better fishing materials were introduced. Lake Itasy was over-exploited between 1960 and 1965 and the stocks did not reconstitute themselves. Many of the other areas, such as the Pangalanes, are recorded to be unproductive and intensively exploited.

4.3 Future development possibilities

No great increases in natural fish production can be anticipated from the inland and brackish waters of Madagascar. They are at present intensively exploited and need rational management to maintain their present levels of productivity. Further growth of the inland fisheries sector could occur through fish culture and intensive management of inland water bodies by stocking and feeding.

5. KEY BIBLIOGRAPHY

Collart & Rabelahatra, 1977
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Rabelahatra, 1988

6. WATER BODIES DIRECTORY

Lakes

Alaotra
Anosy
Antsohaly-Fenoarivo
Bemamba
Ihotry
Itasy
Kinkony
Mahazoarivo
Mandroseza
Mandrozo
Montagne d'Ambre Lakes Complex
Namonty
Noss Be Crater Lakes Complex
Tsimanampetsotsa

Rivers

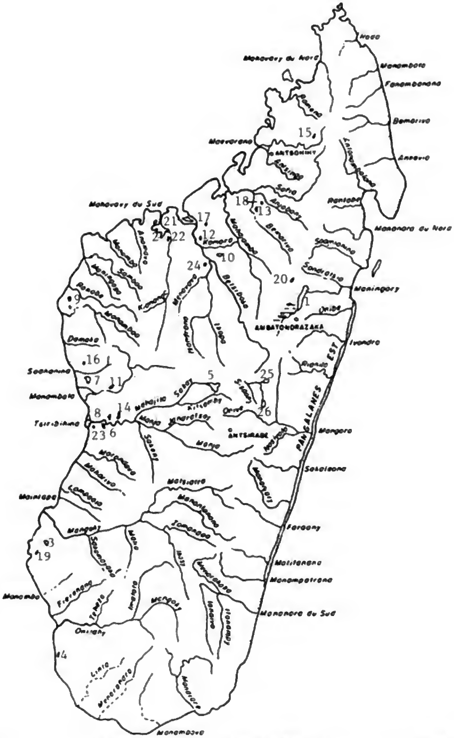
Betsiboka
Sofia
Tsiribihina

Reservoirs

Ambilivily
Antanifotsy
Ivakoana
Mantasoa
Maroala
Maromandia
Sahamaloto
Tsiazompaniry

Lagoons

Ampahana
Anony
Fort-Dauphin Lagoon Complex
Loza
Masianaka
Pangalanes-East Lagoon Complex



1 Alaotra
2 Kinkony
3 Ihotry
4 Tsimanampetsotsa
5 Itasy
6 Komanaomby
7 Bemamba
8 Hima
9 Mandrozo
10 Amparihibe S.
11 Antsohaly
12 Ambanja
13 Amparihibe N.
14 Andranomean N.
15 Ankitrokaka-Matsadio
16 Masiadolo
17 Amboromalandy
18 Tseny
19 Namonty
20 Antsomangana
21 Mitsinjo
22 Katondra
23 Andranomena S.
24 Bendrony-Matsabe
25 Tsiompaniry
26 Mantasoa

Fig. 1. RIVERS AND LAKES OF MADAGASCAR
(Welcomme, 1972)

LAKE ALAOTRA

Geographical data

Location:	Madagascar - 17° 19'-39'S; 48° 27'-38'E
Altitude:	750 m
Surface area:	200 km^2 in dry season; the lake extends over 1 000 km^2 of swamp during the wet season
Max. length:	38 km
Max. width:	9.5 km
Inflowing rivers:	Sahamaloto, Sahabe
Outflowing river:	Maningory

Physical and chemical data

pH:	6.8-7

Fisheries data

Fish species: (Rabelahatra, 1988) *Oreochromis macrochir; O. niloticus; O. mossambicus; Tilapia rendalli; Cyprinus carpio; Micropterus salmoides; Carassius auratus; Anguilla sp.*

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1960	2 250	-	-
1961	2 300	-	-
1962	2 400	-	745
1963	3 000	-	-
1964	3 120	-	-
1965	3 200	1 500	-
1966	3 295	-	-
1967	3 395	-	-
1968	3 530	-	-
1969	3 672	-	-
1970	3 820	1 260	-
1971	3 896	-	-
1972-74	-	-	-
1975	4 000	-	-
1980*	3 700**	2 872	2 478

* Rabelahatra, 1988

** = 168 kg/ha

LAKE ANOSY

Geographical data

Location:	Madagascar - 18° 55'S; 47° 31'E
Surface area:	0.1 km^2
Max. length:	0.5 km
Max. width:	0.4 km

LAKE ANTSOHALY-FENOARIVO

Geographical data
Location: Madagascar - 19° 6'S; 44° 36'E
Altitude: 15 m asl
Surface area: 9.3 km^2
Max. length: 6.5 km
Max. width: 3.5 km

LAKE BEMAMBA

Geographical data
Location: Madagascar - 18° 51'S; 44° 21'E
Altitude: 2 m asl
Surface area: 15.9 km^2
Max. length: 10 km
Max. width: 4.6 km
Outflowing river: lateral spillage from Soahanina River

LAKE IHOTRY

Geographical data
Location: Madagascar - 21° 56'S; 43° 41'E
Surface area: max. 94.2 km^2 rainy season,
min. 8.7 km^2 dry season
Max. length: 13 km
Max. width: 10 km
Inflowing rivers: Andranakanga, Iambinda
Outflowing river: none; internal basin

Physical and chemical data
Ionic composition:

	mg/l
Na	3.6
K	0.20
Ca	0.52
Mg	0.38
Cl	6.0
SO$_4$	1.73
HCO$_3$	0.18

LAKE ITASY

Geographical data
Location: Madagascar - 19° 4'S; 46° 47'E
Altitude: 1 225 m
Surface area: 35 km^2
Depth: 6.5 m (max)
Max. length: 10 km
Inflowing/outflowing river: Sakay (Tsiribihina drainage basin)
Annual fluctuation in level: 1.5 km

LAKE ITASY (cont.)

Physical and chemical data

Surface temperature: 15.5-26° C

pH: 6.8-7.5 (Moreau, 1970)

Fisheries data

Fish species: (Rabelahatra, 1988)
Oreochromis niloticus; Cyprinus carpio; Micropterus salmoides; Tilapia rendalli; Channa sp.; Paratilapia *polleni; Anguilla mossambica; A. nebulosa labiata; A. marmorata; Gambusia holbrooki.*

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1960	1 240	-	-
1961	1 270	-	-
1962	1 300	-	-
1963	1 350	-	-
1964*	1 400	700	200-300
1965	1 340	-	-
1966	1 286	-	-
1967	1 157	-	-
1968	1 040	-	-
1969*	830	700	184
1970	444	-	-
1971	273	-	-
1972-74	-	-	-
1975	300	-	-
1984**	625***	1 000	-

* Welcomme, 1972
** Rabelahatra, 1988
*** = 179 kg/ha

LAKE KINKONY

Geographical data

Location: Madagascar - 6° 9'S; 45° 50'E
Surface area: 139 km^2
Depth: 3-4 m
Max. length: 15 km
Max. width: 10.5 km
Inflowing river: lateral spillage from Mahavavy River

Physical and chemical data

Conductivity: K_{20} 3 379 μS/cm
pH: 6.7-8.3
Ionic composition:

	mg/l
Na	10.7
Ca	11.0-30.0
Mg	7.2-8.0
Cl	17.0-42.0

LAKE KINKONY (cont.)

Fisheries data

Fish species:	(Rabelahatra, 1988) *Megalops cyprinoides; Arius madagascariensis; Oreochromis macrochir; Tilapia rendalli; Chanos chanos; Caranx sp.; Paretroplus petiti; Mugil robustus; Scatophazus tetracanthus; Ambassis sp.*

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen
1960	620	-
1961	635	-
1962	650	-
1963	740	-
1964	760	-
1965	780	-
1966	800	-
1967	780	-
1968	764	-
1969	787	-
1970	810	160
1971	826	-
1972-74	-	-
1975	800	-

LAKE MAHAZOARIVO

Geographical data

Location:	Madagascar - 18° 56'S; 47° 32'E
Surface area:	0.2 km^2
Max. length:	0.8 km
Max. width:	0.4 km

LAKE MANDROSEZA

Geographical data

Location:	Madagascar - 18° 56'S; 47° 32'E

LAKE MANDROZO

Geographical data

Location:	Madagascar - 17° 33'S; 44° 6'E
Altitude:	6 m asl
Surface area:	14.4 km^2
Max. length:	6.5 km
Max. width:	4.0 km

MONTAGNE D'AMBRE LAKES COMPLEX

Geographical data
Location: Madagascar - 12° 35'S; 49° 10'E
Special features: a group of nine small mountain lakes:

Mahery (=Sakaramy):
0.35 km^2, 350 m asl;

Texier, Grand, Petit, Maudi, Amparihy,
Tsivahiny, Fantany (=Ampatinambohitra):
0.34 km^2, 600 m asl;

Tanavo (= Antanavo, Sacre d'Anivorano):
1.49 km^2, 380 m asl

LAKE NAMONTY

Geographical data
Location: Madagascar - 22° 04'S; 43° 25'E
Surface area: 5.97 km^2
Max. length: 11 km
Max. width: 2.5 km

NOSSI BE CRATER LAKES COMPLEX

Geographical data
Location: Madagascar - 13° 20'S; 48° 13'E
Special features: a group of small crater lakes situated on Nossi Be Island:

Lake Amparihibe: 1.38 km^2, 60 m asl;

Lake Andjavibe: 0.31 km^2, 7 m asl;

Lake Antsahamanavaka: 0.39 km^2, 180 m asl;

Lakes Amparihimirahavavy & Antsidihy: 0.27 km^2, 70 m asl;

and Lakes Maintimasoa, Bempaza, Djabala and Ampombilova.

LAKE TSIMANAMPETSOTSA

Geographical data
Location: Madagascar - 24° 05'S; 43° 44'E
Altitude: 34 m asl
Surface area: 29.88 km^2
Special features: highly saline; no fish present

BETSIBOKA RIVER

Geographical data

Source: Falaise de l'Angavo
Altitude: 1 755 m
Total length: 525 km
Drainage area: 11 800 km^2
Countries traversed: Madagascar
Major tributaries: Mahajamba, Isandrano, Ikopa
Discharges to: Indian Ocean (Bombetoka Bay) - 15° 55'S; 46° 25'E
Volume of discharge at mouth: 74.3-678 m^3/sec (monthly mean range)
12 000 m^3/sec (max)
Flood regime: peak flows January to March; minimum in October
Special features: floodplain (circa 805 km^2) present in lower course with 150 lakes of varying size. The largest of these lakes are:

Amparihibe-South	12.5 km^2
Ambanja	9.1 km^2
Amboromalandy	6.5 km^2
Bondrony and Matsiabe	5.0 km^2

Total lakes area is 80 km^2. Two reservoirs (Mantasoa and Tsiazompaniry) are present in the Ikopa tributary basin.

Physical and chemical data

Temperature: 30° C
pH: 6.7
Ionic composition:

	mg/l
Na_2O	3.5
K_2O	2.2
CaCO	1.0
Mg	4.7
Cl	2.8
SO_4	0.1
SiO_2	13.0
Fe_2O_2	3.5
Al_2O_3	0.2

Fisheries data

Total no. of fishermen: 1 250 (in 1970)
Total annual catch: (from floodplain lakes)

Year	Total catch (t)
1960	1 800
1961	1 860
1962	1 900
1963	1 950
1964	2 000
1965	2 100
1966	2 142
1967	2 206
1968	2 275
1969	2 400
1970	2 520
1971	2 600

SOFIA RIVER

Geographical data
Source: Massif du Tsaratanana
Altitude: 1 784 m asl
Total length: 350 km
Countries traversed: Madagascar
Major tributaries: Bemarivo, Anjobony
Discharges to: Indian Ocean (Mahajamba Bay) - 15° 26'S; 47° 13'E
Special features: floodplain (circa 500 km^2) on lower section with over 29 lakes. Largest lakes are Amparihibe-North (8.2 km^2); Tsserry (6.4 km^2); and Marovario (3.2 km^2). Total lakes area is 37.0 km^2.

TSIRIBIHINA RIVER

Geographical data
Source: near Fandriana (Mania tributary)
Altitude: 1 676 m
Total length: 465 km
Countries traversed: Madagascar
Major tributaries: Mahajilo, Sakay, Kitsamby, Mania, Sakeny
Discharges to: Indian Ocean - 19° 40'S; 44° 26'E
Special features: Lake Itasy on Sakay tributary. Large floodplain (circa 700 km^2) on lower reach with over 70 lakes. Total lakes area is 116 km^2.
Largest lakes are:

Komanaomby:	18.1 km^2;
Hima:	15.5 km^2;
Andranomena-South:	7.7 km^2
Andranomena-North:	5.4 km^2;
Sariaka:	4.3 km^2.

AMBILIVILY RESERVOIR

Geographical data
Location: Madagascar
Surface area: 2.35 km^2

ANTANIFOTSY RESERVOIR

Geographical data
Location: Madagascar
Surface area: 1.99 km^2

IVAKOANA RESERVOIR

Geographical data
Location: Madagascar
Surface area: 2.88 km^2

MANTASOA RESERVOIR

Geographical data
Location: Madagascar - 19° 1'S; 47° 52'E
Altitude: 1 385.50 m USL
Date closed: 1935
Surface area: 18 km^2 at USL; 11.50 km^2 (min); 13.75 km^2 (mean)
Depth: 17 m (max); 6.7 m (mean)
Volume: 0.12 km^3
Annual fluctuation level: 7.0 m
Major inflowing river: Varahina
Outflowing river: Varahina

Physical and chemical data
Surface temperature: 0-30° C
pH: 6.6-6.8

Fisheries data
Fish species: (Rabelahatra, 1988)
Tilapia rendalli; Cyprinus carpio; Micropterus salmoides; Carassius auratus
No. of fishermen: 20 in 1970
Total annual catch:

Year	Total catch (t)
1960	6
1961-63	-
1964	8
1965	6
1966	11
1967	12
1968	14
1969	35
1970	55
1971	57
1972-74	-
1975	60

MAROALA RESERVOIR

Geographical data
Location: Madagascar
Surface area: 1.44 km^2

MAROMANDIA RESERVOIR

Geographical data
Location: Madagascar
Surface area: 1.99 km^2

SAHAMALOTO RESERVOIR

Geographical data
Location: Madagascar
Surface area: 2.80 km^2

TSIAZOMPANIRY RESERVOIR

Geographical data
Location: Madagascar - 19° 16'S; 47° 53'E
Altitude: 1 490 m asl
Date closed: 1956
Surface area: 31 km^2 at USL; 18 km^2 (min)
Annual fluctuation level: 9 m
Max. length: 20 km
Max. width: 5 km
Major inflowing river: Varahina-South
Outflowing river: Varahina-South

Fisheries data
Fish species: (Rabelahatra, 1988)
Tilapia rendalli; Cyprinus carpio; Micropterus salmoides; Carassius auratus
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1962	1	-	-
1963-64	-	-	-
1965	2	-	-
1966	7	-	-
1967	9	-	-
1968	10	-	15
1969	45	-	-
1970*	52	68	42 canoes
1971	54	-	-
1972-74	-	-	-
1975	60	-	-

*Source: Rabelahatra, 1988

AMPAHANA LAGOON

Geographical data
Location: Madagascar - 14° 46'S; 50° 13'E
Surface area: 21.8 km^2
Max. length: 5.6 km
Max. width: 1 km
Major inflowing rivers: Andamasina, Bedinta
Outflow: channel to Indian Ocean

Physical and chemical data
pH: 6.6

ANONY LAGOON

Geographical data

Location:	Madagascar - 25° 8'S; 46° 29'E
Surface area:	22.6 km^2
Max. length:	12 km
Max. width:	3 km

FORT DAUPHIN LAGOON COMPLEX

Geographical data

Location:	Madagascar - 24° 47'-25° 9'S; 46° 42'-47° 11'E A series of 11 lagoons, not all interconnected. The main lagoons are: Mananivo, Ambavarano, Lanirano, Andriambe, Andranany, Andratoloharano and Ranofotsy.

LOZA LAGOON

Geographical data

Location:	Madagascar - 14° 37'S; 47° 54'E
Surface area:	156 km^2
Major inflowing rivers:	Doroa, Maevarano
Outflow:	channel to Indian Ocean

Physical and chemical data

Ionic composition:

Cl	0.042-0.181 meq/l
SiO_4-Si	0.8-11.2 mg/l
PO_4-P	0-172.8 μg/l
NO_3-N	0-252 μg/l

MASIANAKA LAGOON

Geographical data

Location:	Madagascar - 23° 35'S; 47° 36'E
Surface area:	13.3 km^2
Max. length:	8 km
Max. width:	3.2
Major inflowing rivers:	Masianaka, Mahasakoho
Outflow:	channel to Indian Ocean

PANGALANES-EAST LAGOON COMPLEX

Geographical data

Location:	Madagascar - 18° 10'-22° 49'S; 47° 49'-49° 24'E Consists of a chain of more than 18 lagoons connected by the Pangalanes canal.
Surface area:	180 km^2 combined. Largest lagoons are Nosive (36 km^2), Ampitabe, Rasoamasay, Rasoabe, Ihosy, Alanampolsy, Rangazavaka, Morongary and Tampolo.

PANGALANES-EAST LAGOON COMPLEX (cont.)

Geographical data (cont.)

Major inflowing rivers: Ivondro, Rianila, Sakanila, Mangoro, Masora, Mananjary, Faraony, Matitanana, Manampatrana

Physical and chemical data

Conductivity: K_{20} 437-1 325 µS/cm

pH: 5.9-7.3

Salinity: 128-1 686 mh/l

Fisheries data

Fish species: (Rabelahatra, 1988)
Caranx melampygus; Ptychochromis oligacanthus; Eleotris fusca; Tilapia rendalli; Mugil robustus; Liza macrolepis; Paretroplus polyactis; Oreochromis mossambicus; Ambassis commersoni; Leognatus equila; Cyprinus carpio.

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1960	320	-	-
1961	330	-	-
1962	340	-	-
1963	350	-	-
1964	358	-	-
1965	365	-	-
1966	381	-	-
1967	390	600	350
1968	398	-	-
1969	390	-	-
1970*	381	600	350 canoes
1971	343	-	-
1972-74	-	-	-
1975	320	-	-

*Source: Rabelahatra (1988)

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MALAWI

1. GEOGRAPHY AND CLIMATE

Malawi has an area of 94 080 km^2, about 20% of which is occupied by Lake Malawi, in the Great Rift Valley. The Great Rift continues from the south end of the lake past the southern borders of the country. East and west of the valley the land rises to form high plateaus, generally between 1 000 and 1 300 m, although the Nyika uplands rise as high as 2 800 m.

In the Rift Valley the climate is hot and humid, especially during the November-April wet season. Elsewhere the climate varies with altitude and can be seasonally very cool.

Malawi is a predominantly rural country. The only major modification to the natural conditions is the barrage across the Shire River below Lake Malombe. This has changed the water regime of the river to a certain degree.

2. HYDROGRAPHY (see Fig. 1)

2.1 Lakes (Welcomme, 1979a)

There are four main lakes in Malawi:

(a) *Lake Malawi* itself covers an area of 30 800 km^2, over half of which is effectively controlled by Malawi. Lake Malawi is a deep Rift Valley lake with a maximum depth of 758 m, the richer shallow southern areas of the lake both lie within Malawi;

(b) *Lake Malombe* is a 390 km^2 lake to the south of Lake Malawi. It is a shallow lateral expansion of the Shire River, whose regime has been stabilized by a flood-control dam downstream;

(c) *Lake Chilwa* is an endorheic lake showing extreme variations in level. It dries out almost completely in some years, but may extend over 2 590 km^2 at highest water when it is surrounded by 1 000 km^2 of marshland. Its mean area is about 750 km^2;

(d) *Lake Chiuta* is a smaller lake of the same type as Lake Chilwa and covers about 200 km^2 when full.

2.2 Rivers, Floodplains and Swamps (Welcomme, 1979a)

The Shire River (520 km) flows from Lake Malawi into the Zambezi. Most of its length is in Malawi, where it floods over large areas to form the Elephant and Ndinde marshes. The total system covers about 1 030 km^2 at peak floods, but reduces in area to 480 km^2 at low water.

2.3 Reservoirs

No important reservoirs as yet, but several are planned for the Shire River. There is one small reservoir on the Zomba Plateau.

FAO/UNDP (1981b), in an appraisal of irrigation, also described numerous reservoirs in the Central Regions, constructed in the 1960's for irrigation. Their present use is mainly for stock watering but, due to poor maintenance, most are in disrepair. These structures represent valuable assets which could be revived. They include not only scope for irrigation but also for fish farming development. Landell Mills Associates (1983) quote inventory records of the Department of Lands, Valuation and Water, showing 700-800 such reservoirs totalling 420-960 ha of water. The average size is 1-2 ha but only 80% are active and the dry season drawdown represents 50% of the potential capacity (Balarin, 1987).

2.4 Coastal Lagoons

None; Malawi is landlocked.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

The status of aquaculture in Malawi has recently been the subject of an EEC-financed study by Landell Mills Associates (1983). In the past it has also been studied by Pruginin (1971, *et seql*)* and Vincke (1981), as well as by local experts such as Msiska (1981, *et seql*)*. Balarin (1987) summarized these studies as follows:

> "The most recent statistics reported by SADCC (1984) report 70 t/yr as the total aquaculture production. Landell Mills Associates (1983) however arrived at 93.6 t/yr from 319 rural small-holder ponds and 26 ha of estate ponds. From data presented in the text of this report as well as Vincke (1981) and Msiska (1982), it is possible to arrive at a better composite picture. From 370 to 500 ponds are implicated, an area approaching 72 ha, with production estimates of 96-104 t/yr. In addition, there are about 700-800 reservoirs totalling nearly 1 000 ha and producing at least 105-192 t/yr. It is possible, therefore, that the total fish farming production may reach 300 t/yr. Landell Mills Associations (1983) recommend a project capable of producing additional 695 t/yr. Meecham (1976) has indicated that over 20 000 ha in the marsh land of the Lower Shire Valley might be suitable for fish farming.
>
> "The main indigenous fish species present in fish ponds are the tilapias (*Oreochromis shiranus chilwae*, *O. mossambicus*, *Tilapia rendalli*) and *Clarias gariepinus*.
>
> "Malawi has been very cautious about fish species introduction for fear of affecting Lake Malawi fishery.
>
> "The first introductions of exotic fish species were of trout, both *Salmo gairdneri* and *Salmo trutta* imported from Wales in 1906. *Micropterus salmoides* were introduced from Zimbabwe as a sport fish in the 1920's. Apart from reservoir stocking and tilapia control trials, this fish has never been cultured in ponds.
>
> "The common carp was introduced from Israel in 1975/76. Yields of *C. carpio* have been higher than tilapia and the species is highly favoured as a polyculture candidate at Domasi and Kasinthula, finding ready market acceptability (Msiska, 1982).

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* see detailed bibliography in Balarin, 1987.

"One exotic species worthy of mention if *Macrobrachium rosenbergii*. This freshwater prawn was introduced in 1976 and cultured at Domasi. Results suggest yields of 300 kg/ha, but maintenance of the hatchery was problematic. In 1984 the Dwangwa Sugar Estate has imported post larvae from Mauritius for starting a commercial growout operation."

For a total aquaculture production of 103 t in 1987, Vincke (1989, pers. comm.) estimates a production of 83 t of tilapias, 9 t of *Clarias gariepinus*, 3 t of *Cyprinus carpio*, and 8 t of *Macrobrachium rosenbergii*.

For further information on aquaculture, see Balarin, 1987.

3.2 Fish production and per caput supply

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Malawi, 1970-1987

Year	Population '000 1/	Nominal Domestic Production (excluding exports) (t) 2/			Nominal Consumer Supply (exluding imports and exports)* (kg/person)		
		Inland capture	Aqua-culture 3/	Total	Inland capture	Aqua-culture 3/	Total
1970	4 518	66 300 6/	- 4/	66 300	14.7	-	14.7
1971	4 641	73 200 6/	-	73 200	15.7	-	15.7
1972	4 767	84 100 6/	-	84 100	17.6	-	17.6
1973	4 897	69 300	-	69 300	14.1	-	14.1
1974	5 030	70 277	-	70 277	14.0	-	14.0
1975	5 167	70 992	-	70 992	13.7	-	13.7
1976	5 315	74 900	-	74 900	14.1	.	14.1
1977	5 467	68 200	-	68 200	12.5	-	12.5
1978	5 623	67 800	-	67 800	12.0	-	12.0
1979	5 784	60 000	-	60 000	10.3	-	10.3
1980	5 950	65 757	-	65 757	11.0	-	11.0
1981	6 137	51 392	-	51 392	8.4	-	8.4
1982	6 329	58 347	69 5/	58 416	9.2	0.01	9.2
1983	6 528	66 917	76 5/	66 993	10.2	0.01	10.2
1984	6 733	64 991	73 5/	65 064	9.6	0.01	9.6
1985	6 944	61 987	80 5/	62 067	8.9	0.01	8.9
1986	7 178	72 762	90 5/	72 852	10.1	0.01	10.1
1987	7 421	88 485	103 5/	88 588	11.9	0.01	11.9

1/ Source: FAO
2/ Source: FAO Fisheries Department FISHDAB
3/ included in "Inland capture" if not specified
4/ - = data not available
5/ Vincke, 1989 (pers.comm.)
6/ cited in Balarin, 1987
* Inland exports were: 1980: 2 522 t; 1981: 1 500 t; 1982: 1 456 t; 1983: 1 500 t.

3.3 Inland catch range and potential yield

Table 2. INLAND CATCH RANGE AND POTENTIAL YIELD

Water body	Period	Annual catch range (t) 1/	Potential annual yield (t) 1/
Lake Chia	-	-	-
Lake Chilwa	1982	15 500	20 000
Lake Chikukutu	-	-	-
Lake Chiuta	1982	1 400	-
Lake Malawi	1982	24 200	73 200-97 600
Lake Malombe	1980-82	6 500-12 100	2 000
Shire River and Elephant Marsh	1982	5 200	4 000-17 000
Rivers Bua, Dwangwa, Lilongwe, Lufira, North Rukuru, Songwe, South Rukuru	1970-82	4 000-17 000 2/	15 000 3/

1/ Sources: see text
2/ NSO, 1984
3/ Welcomme, 1979a

Total annual yield:	56 800-75 400 t (totals, Table 2) 31 000-113 500 t: 1970-1982 production range (NSO, 1984)
Potential annual yield:	114 200-151 600 t (totals, Table 2) 80 000 t (Welcomme, 1979a) 150 000 t (SADCC, 1984)

4. STATE OF THE FISHERY

(adapted from Balarin, 1987; Welcomme, 1979a; and Marshall, 1984a)

4.1 Yield

Malawi fisheries can be classified into three categories: ornamental, commercial and traditional. The ornamental fishery concerns tropical aquarium fish for export and is not considered here.

The statistics of national fishery catches are summarized in Tables 1 and 2. Catch data show a rise in annual landings to a peak of 84 000 t in 1972. At this point, Lake Malawi provided 67.8% of the national catch; it subsequently declined to less than 41% in 1982. Production from other sources has also fluctuated: Lake Chilwa yielded 25 800 t in 1979 but was below 3 000 t in 1975; Lake Malombe yielded 12 100 t in 1982 but prior to this landings were never over 8 000 t/yr; the Lower Shire floodplains produced 17 000 t in 1972 but have in recent years remained at 4 000-5 000 t/yr.

4.2 Factors influencing yield

One of the critical factors about Malawi's inland waters is the extent to which they fluctuate, due to climatic changes and variations in lake levels. In 1980, Lake Malawi reached its highest water level in history.

The fishery on Lake Malawi is poorly developed, except in the south, but studies suggest that an annual yield of 30-40 kg/ha may be possible (FAO, 1982a). In inshore waters most of this would be *Haplochromis* spp. but *Engraulicypris sardella* would be most abundant in open waters.

Both Lake Chilwa and Shire Floodplain fisheries are sensitive to climatic variability and can give greatly reduced catches in bad years.

4.3 Future development possibilities

The estimates of potential fish yields for Malawi range from 80 000 t/yr (Welcomme, 1979a) to 150 000 t/yr (SADCC, 1984), whereas the range of maximum/minimum catches since 1970 (Table 1) suggests a potential MSY of 31 000-113 500 t/yr. Catch data indicate a relatively stabilized catch of 55 000-75 000 t/yr since 1970. Welcomme's (1979a) estimate of 80 000 t/yr has been adopted as the average national MSY, pending new data establishing the actual potential yield of Lake Malawi.

There are, however, excellent opportunities for fish culture in the country, which contributed about 103 t to the total yield in 1987; production may be expanded in this manner.

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Lake Malawi: FAO, 1982
Limnology of Malawi: Tweddle & Mkoko, 1986

6. WATER BODIES DIRECTORY

Lakes

Chia
Chilwa
Chikukutu
Chiuta
Malawi/Nyasa
Malombe

Rivers

Bua
Dwangwa
Lilongwe
Lufira
North Rukuru
Shire (and Floodplain)
Songwe
South Rukuru

LAKE CHIA

Geographical data

Location:	Malawi - 13° 8'S; 34° 19'E
Altitude:	471 m
Surface area:	circa 11.2 km^2
Max. length:	8 km
Max. width:	2 km
Outflowing river:	short channel to Lake Malawi/Nyasa
Special features:	Lake Chia, also called Chia Lagoon, is a lagoon-like lake outflowing into Lake Malawi.

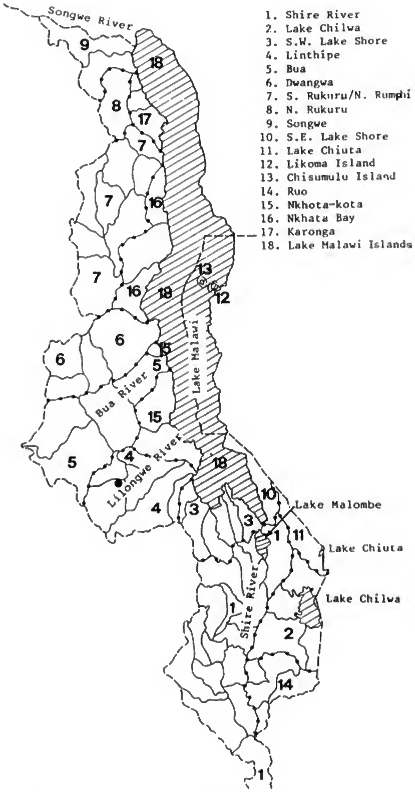

Fig. 1. MAJOR RIVER CATCHMENTS OF MALAWI
(Smith-Carington & Chilton, 1983)

LAKE CHILWA

(International water)

Geographical data

Location: Malawi, Mozambique - 15° 15'S; 35° 45'E

Altitude: 654 m

Surface area: very variable: 259-2 590 km^2; mean: 750 km^2 with a surrounding swampy area of 1 000 km^2. Only a minute portion of the lake is situated in Mozambique (29 km^2 max.).

Depth: 5 m (max); 2 m (mean)

Max. length: 45 km

Max. width: 32 km

Major inflowing rivers: Thondwe, Likangala, Sombani

Outflowing river: none; internal basin

Annual fluctuation in level: 1.3 m (the lake may dry up completely on occasions)

Physical and chemical data

Surface temperature: 21-37° C (Kalk, 1969)

Surface water characteristics in the open water of Lake Chilwa in a 'normal' year (1970) *(Source: Mepham, 1987a)*

	February	*July*	*December*
Depth: (m)	2.05	1.55	1.0
Conductivity: (µS/cm)	800	1 500	2 500
pH:	8.2	8.6	8.8
Total alkalinity: (meq/l)	7.15	8.7	19.0
Oxygen: (mg/l)	5.6	10.0	6.7
Transparency: (Secchi) (cm)	7.5	8.5	11.0
Ionic composition:	mg/l	mg/l	mg/l
Na^+	189	350	780
K^+	14.0	10.5	23.1
Ca^{2+}	10.8	13.4	13.2
Mg^{2+}	6.4	6.3	8.6
Cl^-	182	277	515
	µg/l	µg/l	µg/l
PO_4-P	1 240	1 214	2 000
NO_3-N	n.d.	n.d.	59

Fisheries data

No. of fish species: 28 (cited in Balarin, 1987)

Main catches: *Oreochromis shiranus; Barbus paludinosus; Clarias gariepinus.* (Mepham, 1987a)

No. of fishermen: 700 (Chaika, 1982)

Total annual catch and effort: in Malawi (varies with water level and area):

Year	Total catch (t)	Year	Total catch (t)
1962	3 500	1972	5 246
1963	3 262	1973	1 903
1964	5 255	1974	3 171
1965	8 820	1975	2 808
1966	7 100	1976	21 200
1967	3 139	1977	20 800
1968	97	1978	17 800
1969	3 326	1979	25 800
1970	4 166	1980	19 400
1971	3 595	1981	8 600
		1982	15 500

Potential annual yield: 20 000 t in Malawi (for max area) (Chaika, 1982)

Specific reference: detailed data and bibliography in Mepham, 1987a.

LAKE CHIKUKUTU

Geographical data

Location:	Malawi - 12° 56'S; 34° 13'E
Surface area:	2.5 km^2
Max. length:	3.5 km
Max. width:	1 km
Major Inflowing river:	lateral spillage from Kaombe River

LAKE CHIUTA
(International water)

Geographical data

Location:	Malawi, Mozambique - 14° 45'S; 35° 50'E
Altitude:	620 m
Surface area:	total: 200 km^2 (40 km^2 in Mozambique)
Depth:	5 m
Max. length:	21 km
Max. width:	8 km
Catchment area:	2 000 km^2
Outflowing river:	Lugenda
Special features:	a sandbar only 25 m higher than the floodplain separates Lake Chiuta from Lake Chilwa (Mepham, 1987a)

Physical and chemical data (Welcomme, 1972)

Surface temperature:	21-37° C
Conductivity:	K_{20} 150 μS/cm
pH:	7.0-8.0
Dissolved solids:	0.10-0.15 g/l

Fisheries data

No. of fish species: 40 (cited in Balarin, 1987)

No. of fishermen: 200 (Chaika, 1982, Welcomme, 1972)

Total annual catch: in Malawi

Year	Total catch (t)
1965	181
1971	900
1972	1 400
1973	800
1974	900
1975	700
1976	1 800
1977	1 500
1978	1 700
1979	1 600
1980	800
1981	900
1982	1 400

LAKE MALAWI/NYASA

(International water)

Geographical data (Welcomme, 1972)
Location: Malawi, Mozambique, Tanzania
Altitude: 471 m
Surface area: 30 800 km^2 (24 400 km^2 in Malawi; 6 400 km^2 in Mozambique) Tanzania claims 5 569 km^2 of Malawian waters (see Fig. 2)
Depth: 758 (max); 426 (mean)
Volume: 8 400 km^3
Max. length: 603 km
Max. width: 87 km
Shoreline: 1 500 km (total lake); 300 km in Tanzania
Catchment area: 65 000 km^2
Annual fluctuation in level: 6 m
Major inflowing rivers: Ruhuhu, Songwe
Outflowing river: Shire
Special features: Although Tanzania has some 300 km of shoreline on the lake, the Nyasa area is remote from major centres of population, development activity has been minimal over the years, and the evolution of the fisheries has not been well documented. It is not known to what extent the development of the Nyasa fisheries is complicated by the question of territorial jurisdiction. Around the time of independence it was reported that the formal border between Malawi and Tanzania coincided with the Tanzanian shoreline so that, in theory, all the waters of the lake belonged to Malawi (Dibbs, 1964).

Physical and chemical data (Jackson et *al.*, 1963)
Surface temperature: 23-25° C
Conductivity: K_{20} 220 μS/cm
pH: 7.7-8.6
Alkalinity: N x 10^{-4}: 20.0-25.9

Ionic composition:	(Jackson et *al.*, 1963)	(Talling & Talling, 1965)
	mg/l	mg/l
Na	-	21.0
K	-	6.4
Ca	15.1-20.2	19.8
$CaCO_3$	100.0-129.0	-
$HCO_3 + CO_3$	-	144.0
Mg	6-9	4.7
Cl	-	4.3
SO_4	-	<5.0-5.5
SiO_2	1.5-7.0	1.1
NO_3-N	0.02	-
PO_4-P	0.1-0.2	-

Fisheries data
No. of fish species: 245 described species, of which 193 are cichlids (Greenwood, 1964)
Main catches: inshore waters: *Haplochromis* spp.
open waters: *Engraulicypris sardella* (Marshall, 1984a)
No. of fishermen: *in Malawi:* 6 500 (Welcomme, 1972)
7 200 (Chaika, 1982)
in Tanzania: 3 654 (Welcomme, 1972)
No. of boats: *in Malawi:* 1 125 total (1 000 canoes; 100 dinghies; 25 boats) (Welcomme, 1972)
4 000 (Chaika, 1982)
in Tanzania: 1 898 canoes (Welcomme, 1972)

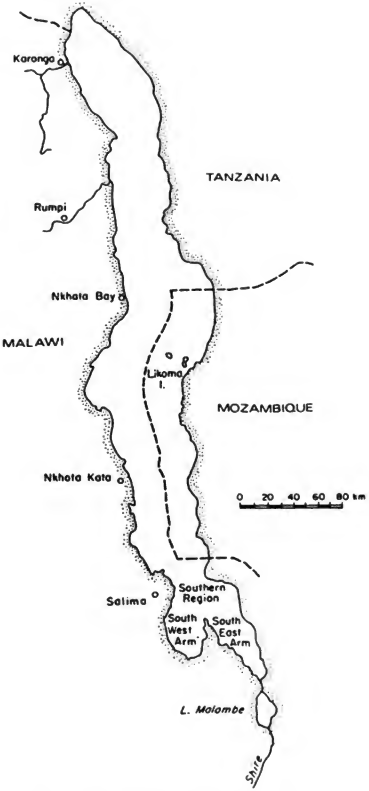

Fig. 2. LAKES MALAWI AND MALOMBE
(Welcomme, 1972)

LAKE MALAWI/NYASA (cont.)

Fisheries data (cont.)
Total annual catch: in Malawi

Year	Total catch (t)
1962	7 938
1965	6 441
1970	44 000
1971	54 000
1972	57 000
1973	54 800
1974	52 200
1975	47 200
1976	36 500
1977	33 900
1978	33 600
1979	22 400
1980	30 200
1981	25 300
1982	24 200
1986	36 400

Potential annual yield: 73 200 - 97 600 t in Malawi
(productivity 30-40 kg/ha/yr: FAO, 1982a)

Specific reference: FAO, 1982a

LAKE MALOMBE

Geographical data
Location: Malawi - 14° 40'S; 35° 15'E (see Fig. 2)
Altitude: 470 m
Surface area: 390 km^2
Depth: 6 m (max); 4 m (mean)
Max. length: 29 km
Max. width: 17 km
Major inflowing river: Shire
Outflowing river: Shire (Lake Malombe represents a lateral extension of the Shire River to form a permanent floodplain).

Physical and chemical data (Jackson *et al.*, 1963)
Conductivity: K_{20} 225 $\mu S/cm$
Alkalinity: $N \times 10^{-4}$ 25.3
Ionic composition:

	mg/l
Ca	18.4
Mg	8.3
$CaCO_3$	126.5
SiO_2	2

Fisheries data
No. of fish species: 90 (cited in Balarin, 1987)
No. of fishermen: 780 (1962) (includes the Shire River)
900 (Chaika, 1982)
No. of boats: 500 (300 canoes, 200 dinghies) (Welcomme, 1972)
360 (Chaika, 1982)

LAKE MALOMBE (cont.)

Fisheries data (cont.)

Total annual catch:

Year	Total catch (t)
1962	1 361 (includes upper Shire River)
1965	1 542 (includes upper Shire River)
1971	5 000
1972	3 100
1973	2 100
1974	4 200
1975	8 100
1976	6 100
1977	6 400
1978	6 100
1979	3 600
1980	6 500
1981	8 500
1982	12 100

Potential annual yield: 2 000 t (Chaika, 1982)

BUA RIVER

Geographical data

Source: Dzalanyama Mountains
Total length: 255 km
Countries traversed: Malawi
Major tributaries: Rusa, Namitete
Discharges to: Lake Malawi/Nyasa - 12° 45'S; 34° 17'E
Volume of discharge at mouth: 184 m^3/sec (max); 0.141 m^3/sec (min)

DWANGWA RIVER

Geographical data

Source: Kasungu National Park
Altitude: 1 338 m
Total length: 175 km
Countries traversed: Malawi
Major tributaries: Mapasazi, Lingadzi, Chitete
Discharges to: Lake Malawi - 12° 31'S; 34° 12'E
Special features: Bana Swamp near mouth

LILONGWE RIVER

Geographical data

Source: Dzalanyama Mountains
Altitude: 1 713 m
Total length: 190 km
Countries traversed: Malawi
Major tributaries: Linthipe
Discharges to: Lake Malawi - 13° 55'S; 34° 34'E
Volume of discharge at mouth: 963 m^3/sec (max)
Special features: Kamuzu dam on upper course

LUFIRA RIVER

Geographical data
Source: near Wenya
Total length: 90 km
Countries traversed: Malawi
Major tributaries: Mbalisi
Discharges to: Lake Malawi/Nyasa - 9° 49'S; 33° 55'E
Volume of discharge at mouth: 113 m^3/sec (max); 0.057-0.141 m^3/sec (min)

NORTH RUKURU RIVER

Geographical data
Source: Nyika Plateau
Altitude: 2 340 m
Total length: 125 km
Countries traversed: Malawi
Discharges to: Lake Malawi/Nyasa - 9° 54'S; 33° 57'E
Volume of discharge at mouth: 680 m^3/sec (max); 0.085-1.13 m^3/sec (min)

SHIRE RIVER AND FLOODPLAIN
(International water)

Geographical data
Source: Lake Malawi/Nyasa (see Figs. 1 and 2)
Altitude: 470 m
Total length: 520 km (375 km in Malawi; 75 km along Malawi-Mozambique frontier; 70 km in Mozambique)
Countries traversed: Malawi, Mozambique
Discharges to: Zambezi River - 17° 42'S; 35° 19'E
Volume of discharge at mouth: 283-566 m^3/sec
Flood regime: Floods between January and April

Special features: in Malawi: Lake Malombe in upper course and Elephant Marsh floodplain/swamp in lower course (500 km^2 flooded permanently and up to circa 1 000 km^2 flooded during rainy season)

Physical and chemical data (Welcomme, 1972)

	Upper course	Middle course	Lower course
Conductivity: K_{20} $\mu S/cm$	220	-	225
Temperature: °C	10-25	20-31	20-35
pH:	7.5-8.2	-	-

Fisheries data
No. of fishermen: 4 000 (Welcomme, 1972)
Total annual catch: in Malawi (excluding Lake Malombe)

Year	Total catch (t)
1965	1 814 (lower Shire River only)
1969	6 944
1970	8 267
1971	9 700

SHIRE RIVER AND FLOODPLAIN (cont.)

Fisheries data (cont.)

Year	Total catch (t)
1972	17 300
1973	9 800
1974	9 700
1975	12 100
1976	9 300
1977	5 600
1978	8 600
1979	6 400
1980	3 900
1981	4 000
1982	5 200

Potential annual yield: 4 000-17 000 t, including floodplain (FAO, 1983)

SONGWE RIVER

(International water)

Geographical data

Source:	near Vwawa, Tanzania
Altitude:	1 877 m
Total length:	165 km (140 km along Tanzania-Malawi frontier; 25 km in Tanzania only)
Countries traversed:	Tanzania, Malawi
Discharges to:	Lake Malawi/Nyasa - 9° 43'S; 33° 57'E

SOUTH RUKURU RIVER

Geographical data

Source:	Viphya Mountains
Altitude:	1 809 m
Total length:	295 km
Drainage area:	11 482 km^2
Countries traversed:	Malawi
Major tributaries:	Kasitu, Luwewya, Mzimba
Discharges to:	Lake Malawi/Nyasa - 10° 45'S; 34° 13'E

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MAURITIUS

1. GEOGRAPHY AND CLIMATE

Mauritius (area of 1 850 km^2) is a volcanic island composed mainly of basalt rock. It is situated in the southwest of the Indian Ocean between 57°18' and 57°48' East and between 19°50' and 20°31' South. It is almost entirely surrounded by a barrier coral reef which encloses a lagoon of 243 km^2. The inland topography is dominated by three mountain ranges situated in the northwest, southeast and southwest regions and a central plateau which rises to 600 m above sea level.

The climate of Mauritius is determined by its oceanic position and location at 20°S in the belt of the southeast Trade Winds. These winds are stronger in the winter and weaker in summer. About 70% of the rainfall occurs between December and May.

Although Mauritius is predominantly agricultural, there has been rapid industrial growth. Industrial effluents, herbicide and pesticide residues occasionally give rise to pollution problems in localised areas.

2. HYDROGRAPHY

2.1 Lakes

There are two small natural lakes: Grand Bassin and Bassin Blanc. Because of their small area their contribution to fisheries is negligible.

2.2 Rivers, Floodplains and Swamps

Most of the rivers (i.e., Tamarin, Black, Poste, Grand) have their source in the central plateau. The rivers and their tributaries are swift-flowing, of steep gradient interspersed by falls and cascades, although there are also extensive reaches of quiet, slow-moving water in some rivers. The rivers have a total length of 499 km and cover an area of about 331 hectares.

2.3 Reservoirs

There are 10 reservoirs on the island covering an area of about 15 km^2. Another fairly large reservoir is under construction for the Champagne Hydroelectric project.

2.4 Coastal Lagoons

There are 25 artificial lagoons (barachois) along the coastline with a combined area of 2.88 km^2.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

Total pond area in 1982 was circa 20 ha. Aquaculture production by species is given in Table 1:

Table 1. Aquaculture production (t), by species - Mauritius, 1982-1987

Species	1982	1983	1984	1985	1986	1987
Marine aquaculture						
Osteichthyes (marine)	11	12	16	16	11	15
Scylla serrata	-	-	1	1	1	4
Crassostrea cucullata	-	-	1	8	8	10
Inland aquaculture						
Cyprinidae	1	1	1	3	3	5
Macrobrachium rosenbergii	22	23	23	25	27	35
Total	34	36	42	53	50	69

Source: Vincke (1989, pers.comm.)

3.2 Fish production and per caput supply

Table 2. FISH PRODUCTION AND PER CAPUT SUPPLY - Mauritius, 1970-1987

		Nominal Production (including exports) (t) 2/ 6/				Nominal Consumer Supply (including exports) (kg/person)			
Year	Population '000 1/	Inland capture 5/	Aqua-culture 3/	Marine capture 2/	Total	Inland capture 5/	Aqua-culture 3/	Marine capture	Total
1970	848	-	-	3 100	3 100	-	-	3.6	3.6
1971	852	-	-	3 500	3 500	-	-	4.1	4.1
1972	856	-	-	4 800	4 800	-	-	5.6	5.6
1973	860	-	0 2/	6 400	6 400	-	0	7.4	7.4
1974	864	-	0 2/	7 679	7 679	-	0	8.9	8.9
1975	868	-	0 2/	7 038	7 038	-	0	8.1	8.1
1976	880	-	0 2/	6 660	6 660	-	0	7.5	7.5
1977	896	-	1 2/	7 667	7 668	-	0.001	8.5	8.5
1978	915	-	5 2/	7 106	7 111	-	0.005	7.8	7.8
1979	935	-	15 2/	6 549	6 564	-	0.01	7.0	7.0
1980	955	-	16 2/	6 365	6 381	-	0.01	6.7	6.7
1981	975	-	25 2/	7 104	7 129	-	0.02	7.3	7.3
1982	994	-	23 4/	9 539	9 562	-	0.02	9.6	9.6
1983	1 013	-	24 4/	9 894	9 918	-	0.02	9.8	9.8
1984	1 050	-	24 4/	10 728	10 752	-	0.02	10.4	10.4
1985	1 031	-	28 4/	12 321	12 349	-	0.03	11.8	11.8
1986	1 067	-	30 4/	12 855	12 885	-	0.03	12.1	12.1
1987	1 085	-	40 4/	17 952	17 992	-	0.04	16.6	16.6

1/ Source: FAO
2/ Source: FAO Fisheries Department FISHDAB (Statistics)
3/ Inland aquaculture
4/ Vincke, 1989 (pers.comm.)
5/ data not available
6/ from 1980 to 1983, Marine exports were as follows:
1980: 1 650 t; 1981: 1 534 t; 1982: 2 346 t; 1983: 1 680 t

3.3 Inland catch range and potential yield

The only figure available is for inland aquaculture, as shown below. No data are available for Reservoirs Eau Bleue, La Dagotiere, La Ferme, La Nicoliere, Mare aux Vacoas, Mare Longue, Midlands, Piton du Milieu, Tamarin Falls, and Valetta; or for Lagoons Basin Humbert, and Belcourt Bay.

Total annual yield: inland aquaculture: 40 t in 1987.

4. STATE OF THE FISHERY

4.1 Yield

There is considerable angling activity on the reservoirs and rivers, but no catch data is available.

Recorded aquaculture yields are from ponds and artificial lagoons (barachois). Aquaculture production is given under section 3.1.

4.2 Factors influencing yield

Probably heavy drawdowns (>10 m) on many reservoirs and in some cases pollution.

4.3 Future development possibilities

Aquaculture ponds with potential of producing 50 tons of prawns and fin fish exist in the country. There is a good prospect of increasing the number of aquaculture ponds. Production from the reservoirs and rivers can also be enhanced. Stocking of irrigation reservoirs with carps is being undertaken and this will result in increased production from these water bodies. Introduction of extensive culture practices could increase yields by a factor of 2 or more above the "natural" yield level.

5. KEY BIBLIOGRAPHY (none)

6. WATER BODIES DIRECTORY

Lakes

Bassin Blanc
Grand Bassin

Reservoirs

Eau Bleue
La Dagotiere
La Ferme
La Nicoliere
Mare aux Vacoas
Mare Longue
Midlands
Piton du Milieu
Tamarin Falls
Valetta

Lagoons

Basin Humbert
Belcourt Bay

LAKE BASSIN BLANC

Geographical data
Location: Mauritius - 20°27'S; 57° 27'E

LAKE GRAND BASSIN

Geographical data
Location: Mauritius - 20° 25'S; 57° 29'E

EAU BLEUE RESERVOIR

Geographical data
Location: Mauritius - 20° 18'S; 57° 36'E
Altitude: 362.71 m asl at USL
Surface area: 0.90 km^2 at USL; 0.01 km^2 at low level
Depth: 6.78 m (mean at USL)
Volume: 6.1 x 10^6 m^3 at USL
Annual fluctuation level: 18.29 m
Major inflowing river: Eau Bleue

LA DAGOTIERE RESERVOIR

Geographical data
Location: Mauritius - 20° 14'S; 57° 34'E
Surface area: 0.20 km^2 at USL

LA FERME RESERVOIR

Geographical data
Location: Mauritius - 20° 15'S; 57° 25'E
Altitude: 146 m asl at USL
Surface area: 2.27 km^2 at USL; 0.09 km^2 at low level
Depth: 5.20 m (mean at USL)
Volume: 11.8 x 10^6 m^3
Annual fluctuation in level: 13.41 m
Major inflowing rivers: irrigation feeder channels

Physical and chemical data
pH: 8.6
Ionic composition: Na 14 mg/l
K 1.2 mg/l
Total dissolved solids: 260 mg/l

LA NICOLIERE RESERVOIR

Geographical data

Location: Mauritius - 20° 10'S; 57° 36'E
Altitude: 249.02 m asl at USL
Surface area: 0.94 km^2 at USL; 0.3 km^2 at low level
Depth: 6.15 m (mean at USL)
Volume: 5.78 x 10^6 m^3 at USL
Annual fluctuation in level: 11.28 m
Major inflowing river: Rempoli

MARE AUX VACOAS RESERVOIR

Geographical data

Location: Mauritius - 20° 22'S; 57° 30'E
Altitude: 565.71 m asl at USL
Surface area: 5.26 km^2 at USL; 0.04 km^2 at low level
Depth: 5.25 m (mean at USL)
Volume: 27.6 x 10^6 m^3 at USL
Annual fluctuation in level: 10.36 m
Major inflowing rivers: Grand Ruissero, Poste
Outflowing river: Tamarin

Physical and chemical data

pH: 7.0-7.4
Ionic composition: Na 8 mg/l
K 1.3 mg/l
Total dissolved solids: 130 mg/l

MARE LONGUE RESERVOIR

Geographical data

Location: Mauritius - 20° 22'S; 57° 27'E
Altitude: 576.07 m asl at USL
Surface area: 0.965 km^2 at USL; 0.08 km^2 at low level
Depth: 6.51 m (mean at USL)
Volume: 6.28 x 10^6 m^3 at USL
Annual fluctuation in level: 10.36 m
Major inflowing river: Aigrettes

Physical and chemical data

pH 6.9

MIDLANDS RESERVOIR

Geographical data

Location: Mauritius
Surface area: 2.51 km^2 at USL
Depth: 6.22 m (mean at USL)
Volume: 15.6 x 10^6 m^3 at USL

PITON DU MILIEU RESERVOIR

Geographical data
Location: Mauritius - 20° 17'S; 57° 34'E
Altitude: 437.39 m asl at USL
Surface area: 0.688 km^2 at USL; 0.05 km^2 at low level
Depth: 4.61 m (mean at USL)
Volume: 3.17×10^6 m^3 at USL
Annual fluctuation in level: 10.67 m
Major inflowing rivers: Martin, Vacoas

Physical and chemical data
pH: 7.2
Ionic composition: Na 7.2 mg/l
K 0.6 mg/l
Total dissolved solids: 420 mg/l

TAMARIN FALLS RESERVOIR

Geographical data
Location: Mauritius - 20° 21'S; 57° 27'E
Altitude: 493.78 m asl at USL
Surface area: 0.715 km^2 at USL; 0 km^2 at low level
Depth: 3.36 m (mean at USL)
Volume: 2.4×10^6 m^3 at USL
Annual fluctuation in level: 6.40 m
Major inflowing rivers: Tamarin, Aigrettes
Outflowing river: Bambous

VALETTA RESERVOIR

Geographical data
Location: Mauritius - 20° 15'S; 57° 34'E
Surface area: 0.60 km^2 at USL

BASIN HUMBERT LAGOON

Geographical data
Location: Mauritius
Surface area: 0.52 km^2
Special features: artificial lagoon

BELCOURT BAY LAGOON

Geographical data
Location: Mauritius
Surface area: 0.45 km^2
Special features: artificial lagoon

MOZAMBIQUE

1. GEOGRAPHY AND CLIMATE (mainly after Welcomme, 1979a)

The country (with a surface area of 784 090 km^2) is divided into three areas:

(a) coastal lowlands, comprising about 44% of the country;
(b) central uplands, formed by plateaus of between 200 and 600 m, making up about 17% of the area; and
(c) a higher plateau, from 600 to 1 000 m, making up a further 26%.

Finally, there are mountainous areas along the western frontier.

The climate varies from tropical to subtropical, but becomes more temperate in the high plateau and mountainous areas. There is a warm, rainy season from November to March. Rainfall is irregular, particularly in the south.

Mozambique is an entirely agricultural country.

2. HYDROGRAPHY (mainly after Welcomme, 1979a)

(Direcção Provincial dos Serviços Hidráulicos (1969) gives a complete listing of the inland waters of Mozambique.)

2.1 Lakes

Mozambique has 6 400 km^2 (21%) of Lake Malawi. Lakes Chilwa and Chiuta lie partly within Mozambique. Both these lakes have highly variable areas, due to the irregularities of rainfall. In addition, there are over 1 000 catalogued small and medium-sized permanent lakes, and an unknown number of seasonal lakes.

2.2 Rivers, Floodplains and Swamps

The main river is the Zambezi, which flows for its last 800 km through Mozambique before entering the Indian Ocean. Other important rivers are the Limpopo (400 km) and the Save (300 km). There are many smaller coastal rivers which, by reason of the irregularities of the rainfall patterns, have hydrological regimes which vary widely from spate to flood.

2.3 Reservoirs

One major reservoir has been installed on the Zambezi River behind the dam at Cahora Bassa. This reservoir has an area of 2 665 km^2. There are several other smaller reservoirs of importance.

2.4 Coastal Lagoons

There are over 540 km^2 of brackishwater lagoons situated in over 400 water bodies.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

Production from freshwater aquaculture in 1987 reached 21 t, including 4 t of *Cyprinus carpio* and 17 t of tilapias (Vincke, 1989, pers.comm.). No data are available on the number and area of ponds.

3.2 Fish production and per caput supply

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Mozambique, 1970-1987

		Nominal Domestic Production (excluding exports) (t) 2/				Nominal Consumer Supply (excluding imports and exports) (kg/person)			
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Marine capture	Total	Inland capture	Aqua-culture 3/	Marine capture	Total
1970	8 140	- 4/	-	7 600	7 600	-	-	0.9	0.9
1971	8 434	-	-	10 400	10 400	-	-	1.2	1.2
1972	8 738	-	-	10 400	10 400	-	-	1.2	1.2
1973	9 054	0	-	13 300	13 300	0	-	1.5	1.5
1974	9 380	0	-	15 660	15 660	0	-	1.7	1.7
1975	9 719	0	-	12 460	12 460	0	-	1.3	1.3
1976	10 158	0	-	14 900	14 900	0	-	1.5	1.5
1977	10 617	5 000 6/	-	13 950	18 950	0.5	-	1.3	1.8
1978	11 097	5 000	-	12 940	17 940	0.4	-	1.2	1.6
1979	11 599	5 000	-	25 130	30 130	0.4	-	2.2	2.6
1980	12 123	5 000	-	30 350	35 350	0.4	-	2.5	2.9
1981	12 470	5 000	-	37 130	42 130	0.4	-	3.0	3.4
1982	12 827	5 000	-	34 680	39 680	0.4	-	2.7	3.1
1983	13 195	5 000	-	37 516	42 516	0.4	-	2.8	3.2
1984	13 572	4 000	-	31 847	35 847	0.3	-	2.3	2.6
1985	13 961	3 000	-	33 306	36 306	0.2	-	2.4	2.6
1986	14 342	762	5 5/	31 154	31 921	0.05	0.0003	2.2	2.2
1987	14 733	246	21 5/	35 850	36 117	0.02	0.001	2.4	2.4

1/ Source: FAO
2/ Source: FAO Fisheries Department FISHDAB
3/ included in "Inland capture" if not specified
4/ - = data not available
5/ Vincke, 1989 (pers.comm.)
6/ working estimate from 1977 to 1985

3.3 Inland catch range and potential yield

Table 2.

Water body	Period	Annual catch range (t) 1/	Potential annual yield (t) 1/
Lake Malawi/Nyasa	-	-	19 200-25 600
Cahora Bassa Reservoir	1982	4 300	8 000
Massingir Reservoir	1981	400	-

1/ Sources: see text

No data available for:

Lakes Amaramba, Banamana, Chilwa, Chiuta, Marangua, Neguri, Nhangela, Nhangulaze and Nhavarre;

Rivers Buzi, Incomati/Komati, Limpopo, Luangwa, Lurio, Maputo/Pongolo, Pungoe, Ruvuma, Save/Sabi, Shire/Chire and Zambezi;

Reservoirs Chicamba Real and Pequenos Libombos;

Lagoons Babatilene, Bilene Complex, Bumbe, Buti, Chaguefula, Changue, Chombonhane, Funguene, Inhassoro, Machane, Macumbe, Macumline, Madacanine, Mahanse, Mambeze, Mandjene, Mangalidje, Massanguane, Matibe, Munde, Nela, Nhamanene, Piti, Quissico Complex, Satine, Sugi, Tzembezanhe, Xamane, Xavi, Xingute and Zuali.

Total annual yield: 5 000 t in 1982 (rough estimate, see Table 1)
246 t in 1987

Potential annual yield: 55 000 t (SADCC, 1984)

4. STATE OF THE FISHERIES

4.1 Yield

While no firm estimates exist for production, a figure of about 5 000 t has been advanced as a working estimate. The potential catch of the country is no doubt considerable (c. 55 000 t; c. 30 000 t for Lake Malawi/Nyasa and Cahora Bassa Reservoir). There are extensive resources in lagoons, lakes and rivers, and active fisheries have existed in the past.

4.2 Factors influencing yield

Catches from inland fisheries are very low, mainly because of the drastic shortage of fishing gear and an unstable security situation. Furthermore, communications within the country are very poor and marketing networks are generally absent.

4.3 Future development possibilities

Until there is an amelioration in the internal security situation and also a nationwide increased availability of inexpensive fishing materials, a significant increase in inland fish production cannot be foreseen. Mozambique, in the long term, possesses excellent potential for inland fishery development.

5. KEY BIBLIOGRAPHY

Mikkola, 1982

6. WATER BODIES DIRECTORY

Lakes

Amaramba
Banamana
Chilwa
Chiuta
Malawi/Nyasa
Marangua
Neguri
Nhangela
Nhangulaze
Nhavarre

Rivers

Buzi
Incomati/Komati
Limpopo
Luangwa
Lurio
Maputo/Pongolo
Pungoe
Ruvuma
Save/Sabi
Shire/Chire (& floodplain)
Zambesi

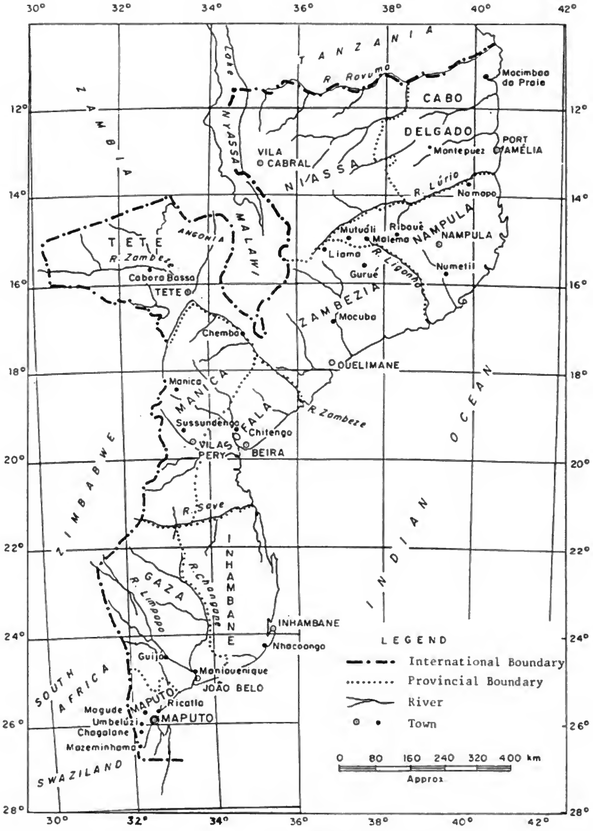

Fig. 1. MAP OF MOZAMBIQUE
(FAO/UNDP, 1981a)

Reservoirs

Cahora Bassa
Chicamba Real
Massingir
Pequenos Libombos

Lagoons

Babatilene
Bilene Complex
Bumbe
Buti
Chaguefula
Changue
Chombonhane
Funguene
Inhassoro
Machane
Macumbe
Macumline
Madacanine
Mahanse
Mambeze
Mandjene (Pandjene)
Mangalidje
Massanguane
Matibe
Munde (Maundo)
Nela
Nhamanene Complex
Piti
Quissico Complex
Satine (Sotiba)
Sugi
Tzembezanhe
Xamane
Xavi (Chavi)
Xingute (Chinguti)
Zuali

LAKE AMARAMBA

Geographical data
Location: Mozambique - 14° 21-38'S; 35° 55'E
Altitude: 655 m
Surface area: 60 km^2
Depth: 5 m (max)
Max. length: 33 km
Max. width: 2 km
Major inflowing rivers: Lugenda (outflow from Lake Chiuta)
Outflowing river: Lugenda

LAKE BANAMANA

Geographical data
Location: Mozambique - 22° 10'S; 33° 55'E
Surface area: 20 km^2
Max. length: 9.5 km
Max. width: 3 km
Outflowing river: none; internal basin

LAKE CHILWA
(International water)

Geographical data
Location: Malawi, Mozambique - 15° 15'S; 35° 45'E
Altitude: 654 m
Surface area: very variable: 259-2 590 km^2; mean: 750 km^2 with a surrounding swampy area of 1 000 km^2. Only a minute portion of the lake is situated in Mozambique (29 km^2 max)
Depth: 5 m (max); 2.0 m (mean)
Max. length: 45 km
Max. width: 32 km
Annual fluctuation in level: 1.3 m (lake may dry up completely on occasions)
Major inflowing rivers: Thondwe, Likangala, Sombani
Outflowing river: none; internal basin

Physical and chemical data
Surface temperature: 21-37° C (Kalk, 1969)

LAKE CHILWA (cont.)

Physical and chemical data (cont.)

Surface water characteristics in the open water of Lake Chilwa in a 'normal' year (1970) *(Source: Mepham, 1987a)*

		February	*July*	*December*
Depth:	(m)	2.05	1.55	1.0
Conductivity:	(µS/cm)	800	1 500	2 500
pH:		8.2	8.6	8.8
Total alkalinity:	(meq/l)	7.15	8.7	19.0
Oxygen:	(mg/l)	5.6	10.0	6.7
Transparency:	(Secchi) (cm)	7.5	8.5	11.0
Ionic composition:		mg/l	mg/l	mg/l
	Na^+	189	350	780
	K^+	14.0	10.5	23.1
	Ca^{2+}	10.8	13.4	13.2
	Mg^{2+}	6.4	6.3	8.6
	Cl^-	182	277	515
		µg/l	µg/l	µg/l
	PO_4-P	1 240	1 214	2 000
	NO_3-N	n.d.	n.d.	59

Fisheries data
No. of fish species: 28 (cited in Balarin, 1987)
Main catches: *Oreochromis shiranus; Barbus paludinosus; Clarias gariepinus* (Mepham, 1987a)
Total annual catch and effort: varies with water level and area
Potential annual yield: 20 000 t (for max area) in Malawi (Chaika, 1982); no data for Mozambique waters.

Specific reference: detailed data and bibliography in Mepham, 1987a.

LAKE CHIUTA
(International water)

Geographical data

Location:	Malawi, Mozambique - 14° 45'S; 35° 50'E
Altitude:	620 m
Surface area:	total: 200 km^2 (40 km^2 in Mozambique)
Depth:	5 m
Max. length:	21 km
Max. width:	8 km
Catchment area:	2 000 km^2
Outflowing river:	Lugenda
Special features:	a sandbar only 25 m higher than the floodplain separates Lake Chiuta from Lake Chilwa (Mepham, 1987a).

Physical and chemical data (Welcomme, 1972)

Surface temperature:	21-37° C
Conductivity:	K_{20} 150 µS/cm
pH:	7.0-8.0
Dissolved solids:	0.10-0.15 g/l

Fisheries data
No. of fish species: 40 (cited in Balarin, 1987)

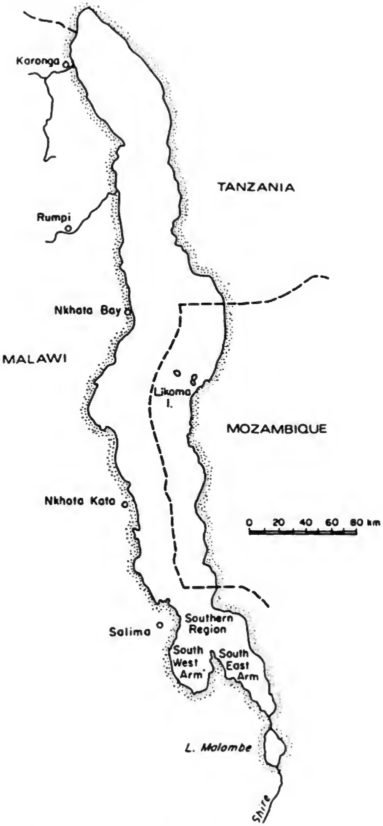

Fig. 2. LAKES MALAWI AND MALOMBE
(Welcomme, 1972)

LAKE MALAWI/NYASA
(International water)

Geographical data (Welcomme, 1972)
Location: Malawi, Mozambique, Tanzania
Altitude: 471 m
Surface area: 30 800 km^2 (24 400 km^2 in Malawi; 6 400 km^2 in Mozambique)
Tanzania claims 5 569 km^2 of Malawian waters (see Fig. 2)
Depth: 758 (max); 426 (mean)
Volume: 8 400 km^3
Max. length: 603 km
Max. width: 87 km
Shoreline: 1 500 km (total lake); 300 km in Tanzania
Catchment area: 65 000 km^2
Annual fluctuation in level: 6 m
Major inflowing rivers: Ruhuhu, Songwe
Outflowing river: Shire
Special features: Although Tanzania has some 300 km of shoreline on the lake, the Nyasa area is remote from major centres of population, development activity has been minimal over the years, and evolution of the fisheries has not been well documented. It is not known to what extent development of the Nyasa fisheries is complicated by the question of territorial jurisdiction. Around the time of independence, it was reported that the formal border between Malawi and Tanzania coincided with the Tanzanian shoreline so that, in theory, all the waters of the lake belonged to Malawi (Dibbs, 1964).

Physical and chemical data (Jackson *et al.*, 1963)
Surface temperature: 23-25° C
Conductivity: K_{20} 220 μS/cm
pH: 7.7-8.6
Alkalinity: N x 10^{-4}: 20.0-25.9
Ionic composition:

	(Jackson *et al.*, 1963)	(Talling & Talling, 1965)
	mg/l	mg/l
Na	-	21.0
K	-	6.4
Ca	15.1-20.2	19.8
$CaCO_3$	100.0-129.0	-
HCO_3+CO_3	-	144.0
Mg	6-9	4.7
Cl	-	4.3
SO_4	-	<5.0-5.5
SiO_2	1.5-7.0	1.1
NO_3-N	0.02	-
PO_4-P	0.1-0.2	-

Fisheries data
No. of fish species: 245 described species, of which 193 are cichlids (Greenwood, 1964)
Main catches: inshore waters: *Haplochromis* spp.
open waters: *Engraulicypris sardella* (Marshall, 1984a)
No. of fishermen: no data available
No. of boats: no data available
Total annual catch and effort: no data available
Potential annual yield: 19 200-25 600 t in Mozambique (30-40 kg/ha/yr: FAO 1982a)

Specific reference: FAO, 1982a

LAKE MARANGUA

Geographical data
Location: Mozambique - 24° 44'S; 34° 14'E
Surface area: 63 km^2
Max. length: 18 km
Max. width: 5 km
Outflowing river: none; internal basin

LAKE NEGURI

Geographical data
Location: Mozambique - 11° 46'S; 40° 05'E
Surface area: 8.4 km^2
Max. length: 4 km
Max. width: 3 km

LAKE NHANGELA

Geographical data
Location: Mozambique - 24° 21'S; 35° 00'E
Surface area: 15.8 km^2
Max. length: 9 km
Max. width: 2.5 km
Outflowing river: none; internal basin

LAKE NHANGULAZE

Geographical data
Location: Mozambique - 24° 00'S; 34° 26'E
Surface area: 14.7 km^2
Max. length: 10.5 km
Max. width: 2 km
Outflowing river: Inhamiquilengue

LAKE NHAVARRE

Geographical data
Location: Mozambique - 23° 47'S; 34° 48'E
Surface area: 22.1 km^2
Max. length: 7 km
Max. width: 4.5 km
Outflowing river: none; internal basin

BUZI RIVER

(International water)

Geographical data
Source: near Chipinga, Zimbabwe
Altitude: 1 326 m
Total length: 360 km total (35 km in Zimbabwe)
Drainage area: 28 800 km^2 total
(25 600 km^2 in Mozambique; 3 200 km^2 in Zimbabwe)
Countries traversed: Mozambique, Zimbabwe
Major tributaries: Revue, Lucite

BUZI RIVER (cont.)

Geographical data (cont.)
Discharges to: Indian Ocean - 19° 52'S; 34° 46'E
Volume of discharge at mouth: 1.45 km^3/yr
Special features: Chicamba Real reservoir on Revue tributary; floodplain along lower course.

INCOMATI/KOMATI RIVER
(International water)

Geographical data
Source: near Breyten, South Africa
Altitude: 1 832 m
Total length: 714 km total (265 km in Mozambique; 95 km in Botswana; 354 km in South Africa)
Drainage area: 46 246 km^2 total (14 925 km^2 in Mozambique; 2 500 km^2 in Swaziland; 28 821 km^2 in South Africa)
Countries traversed: Mozambique, Swaziland, South Africa
Major tributaries: Sabia, Crocodile
Discharges to: Indian Ocean - 25° 49'S; 32° 44'E
Volume of discharge at mouth: 2.3 km^3/yr
Flood regime: unimodal flood peaking in January-February
Special features: several reservoirs including Hartbeespoort and Sand River; floodplain in the lower course, including Lake Chuali (28 km^2) and several smaller lakes.

LIMPOPO RIVER
(International water)

Geographical data
Source: Witwatersrand, South Africa
Altitude: 1 732 m
Total length: 1 680 km
Drainage area: 358 000 km^2 total (79 600 km^2 in Mozambique)
Countries traversed: Botswana, Zimbabwe, Mozambique, South Africa
Major tributaries: Elefantes/Olifants, Nuanetsi, Umzingwani, Shashi, Changane
Discharges to: Indian Ocean - 25° 12'S; 33° 31'E
Volume of discharge at mouth: 5.33 km^3/yr
Special features: numerous dams/reservoirs on tributaries, including Massingir (151 km^2) floodplain along lower course with numerous lakes, including Lakes Gondeza, Pave (2 km^2), Chinanga (5 km^2), Bambene and Linguazi (4 km^2 combined), and Nhangul.

LUANGWA RIVER
(International water)

Geographical data
Source: near Zambia/Malawi frontier
Altitude: 1 658 m asl
Total length: 790 km total (710 km in Zambia; 80 km along Zambian/Mozambique frontier)
Drainage area: 147 500 km^2
Countries traversed: Zambia, Mozambique

LUANGWA RIVER (cont.)

Geographical data (cont.)
Major tributaries: Lukusashi, Lusemfwa
Discharges to: Cahora Bassa Reservoir confluently with the Zambezi River
Volume of discharge at mouth: 8 km^3/yr
Flood regime: main discharge from April to July
Special features: two reservoirs (Mulungushi and Mita Hills) within the Lusemfwa tributary basin.

LURIO RIVER

Geographical data
Source: near Molumbo, Mozambique
Altitude: 1 321 m
Total length: 595 km
Drainage area: 60 800 km^2
Countries traversed: Mozambique
Discharges to: Indian Ocean - 13° 31'S; 40° 32'E
Volume of discharge at mouth: 7.33 km^3/yr

MAPUTO/PONGOLO RIVER
(International water)

Geographical data
Source: Drakensberg Mountains, South Africa
Altitude: 2 277 m
Total length: 565 km total (90 km in Mozambique; 475 km in South Africa)
Drainage area: 29 800 km^2 total (1 570 km^2 in Mozambique; 10 320 km^2 in Swaziland; 17 910 km^2 in South Africa)
Countries traversed: Mozambique, Swaziland (Lusutfu trib. basin), S. Africa
Major tributaries: Lusutfu
Discharges to: Indian Ocean (Maputo Bay) - 26° 11'S; 32° 41'E
Volume of discharge at mouth: 2.8 km^3/yr
Special features: Pongolapoort Reservoir (133 km^2); Pongolo floodplain (130 km^2) with about 90 small lakes between Pongolapoort dam and the confluence with the Lusutfu River. Floodplain along Mozambique stretch with associated lakes (i.e. Lake Mandjane (10 km^2), Lakes Natali and Changare).

PUNGOE RIVER
(International water)

Geographical data
Source: near Watsomba, Zimbabwe
Altitude: 2 033 m
Total length: 300 km (40 km in Zimbabwe)
Drainage area: 29 500 km^2 total (28 000 km^2 in Mozambique; 1 500 km^2 in Zimbabwe)
Countries traversed: Mozambique, Zimbabwe
Major tributaries: Urema, Vunduzi, Nhazonia
Discharges to: Indian Ocean - 19° 51'S; 34° 48'E
Volume of discharge at mouth: 3.08 km^3/yr
Special features: floodplains on lower course and on Urema tributary

RUVUMA RIVER
(International water)

Geographical data
Source: near Songea, Tanzania
Altitude: 1 558 m
Total length: 640 km
Drainage area: 165 760 km^2
(113 701 km^2 in Mozambique; 52 059 km^2 in Tanzania)
Countries traversed: Mozambique, Tanzania
Major tributaries: Lugenda in Mozambique (555 km-long-channel)
Discharges to: Indian Ocean - 10° 28'S; 40° 25'E
Special features: Lakes Chiuta and Amaramba on Lugenda tributary; floodplain and several associated lakes on lower course (i.e., Lake Chidya in Tanzania and Lake Nangade in Mozambique).

SAVE/SABI RIVER
(International water)

Geographical data
Source: Zimbabwe (south of Harare)
Altitude: 1 693 m
Total length: 715 km total (400 km in Zimbabwe; 315 km in Mozambique)
Drainage area: 88 395 km^2 (83 845 km^2 in Zimbabwe; 4 550 km^2 in Mozambique)
Countries traversed: Mozambique, Zimbabwe
Major tributaries: Lundi
Discharges to: Indian Ocean - 20° 58'S; 35° 05'E
Volume of discharge at mouth: 5 km^3/yr
Special features: Several reservoirs within Lundi tributary basin including Kyle, Bangala, Manjirenje and Tokwe Mokorsi

SHIRE/CHIRE RIVER AND FLOODPLAIN
(International water)

Geographical data
Source: Lake Malawi/Nyasa (see Fig. 2)
Altitude: 470 m
Total length: 520 km (375 km in Malawi; 75 km along Malawi-Mozambique frontier; 70 km in Mozambique)
Countries traversed: Mozambique, Malawi
Discharges to: Zambezi River - 17° 42'S; 35° 19'E
Volume of discharge at mouth: 283-566 m^3/sec
Flood regime: floods between January and April
Special features: in Malawi: Lake Malombe in upper course and Elephant Marsh floodplain/swamp in lower course (500 km^2 flooded permanently and up to circa 1 000 km^2 flooded during rainy season)

Physical and chemical data (Welcomme, 1972)

	Upper course	Middle course	Lower Course
Temperature: °C	10-25	20-30	20-35
pH:	7.5-8.2	-	-
Conductivity: K_{20}	220 μS/cm	-	225 μS/cm

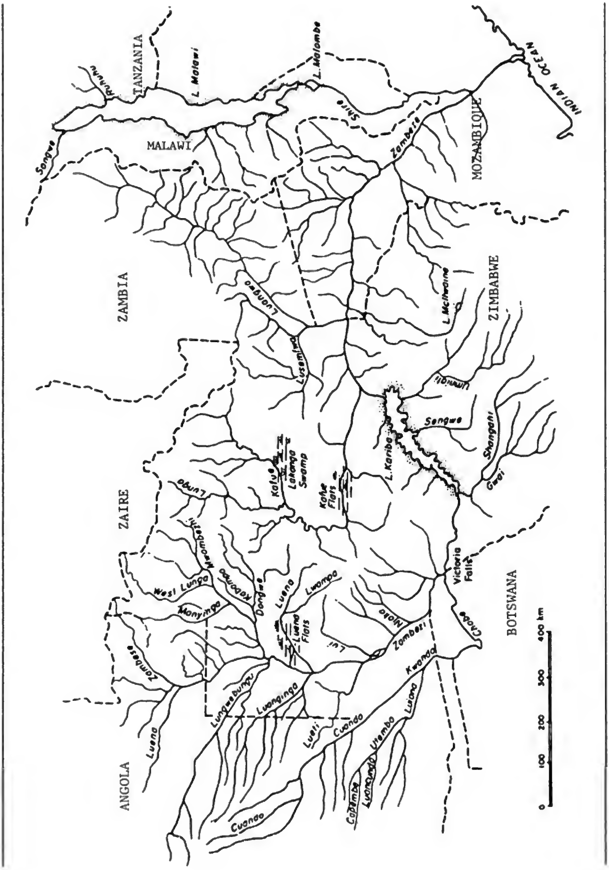

Fig. 3. RIVERS AND LAKES OF THE ZAMBEZI
(Welcomme, 1972)

ZAMBEZI RIVER
(International water)

Geographical data (Welcomme, 1972)
Source: northwest Zambia and eastern Angola (see Fig. 3)
Altitude: 1 600 m
Total length: 2 574 km
Drainage area: 1 300 000 km^2
Countries traversed: Angola, Mozambique, Zambia, Botswana, Namibia, Zimbabwe
Major tributaries: Cuando, Kafue, Luangwa, Shire. The Zambezi system also communicates with the Okovango system via the Chobe River.
Discharges to: Indian Ocean - 18°47'S; 36°E
Volume of discharge at mouth: 7 070 m^3/sec
Flood regime: December to July, maximum in March
Special features: Barotse floodplain (700-9 000 km^2), Kafue flats (200-7 000 km^2), Lukanga swamps (3 000-8 000 km^2), Kariba and Cahora Bassa dams/reservoirs.

Physical and chemical data above Lake Kariba (Coche, 1968)

		Flood	Low water
Temperature:		30°C	17°C
pH:		-	7.4
Conductivity:		K_{20}: 50 µS/cm	96 µS/cm
Total alkalinity:		20 mg/l	44 mg/l
Total hardness:		17.9 mg/l	38.1 mg/l
Ionic composition:		mg/l	mg/l
	Na	1.70	3.26
	K	-	0.88
	Ca	4.93	-
	Mg	1.47	3.86
	NO$_2$-N	0.00376	0.00024
	NO$_3$-N	0.0047	0.0158
	PO$_4$-P	0.0295	0.0078

Fisheries data
No. of fish species: Upper Zambezi: 49; Middle Zambezi: 50 (Jubb, 1961)

CAHORA BASSA RESERVOIR

Geographical data
Location: Mozambique - 15°29'-16°00'S; 30°25'-32°44'E (see Fig. 4)
Altitude: 326 m asl at upper regulated level
Date closed: 1975
Surface area: 2 665 km^2
Depth: 156 m (max); 20.92 m (mean)
Volume: 55.75 km^3
Max. length: 246 km
Max. width: 39.8 km
Shoreline: 1 775 km
Annual fluctuation in level: 6.98-14.06 m
Major inflowing river: Zambezi
Outflowing river: Zambezi

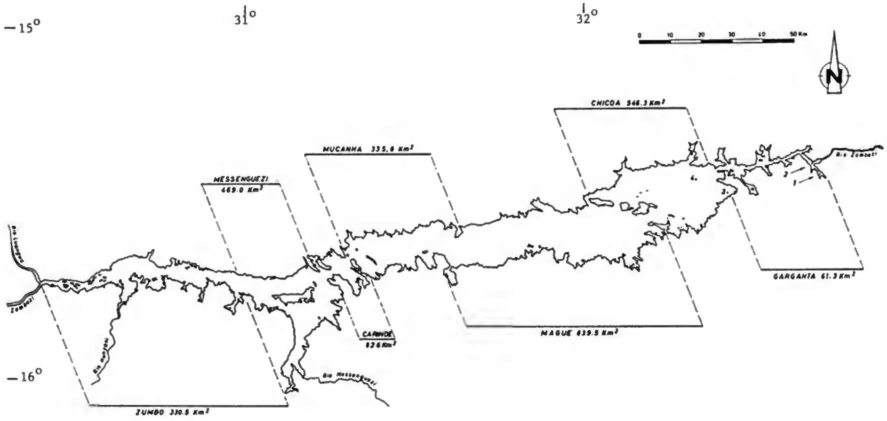

Fig. 4. CAHORA BASSA RESERVOIR
(Gliwicz, 1984)

CAHORA BASSA RESERVOIR (cont.)

Physical and chemical data

Surface temperature: 20.8-23.7°C
Conductivity: K_{20} 112-132 μS/cm
Dissolved solids: 81-114 mg/l
Ionic composition:

	mg/l
Na	2.97-11.13
Ca	6.81-25.65
Mg	1.94-5.72
HCO_3	39.66-97.63
SO_4	2.30-16.62
Fe	0.10-0.14
Mn	0-20
NO_3-N	trace-1.1
NH_3-N	0-0.17
PO_4	trace

Fisheries data

No. of fish species: 33 + the pelagic sardine *Limnothrissa miodon*, which was introduced into Kariba reservoir earlier, and has successfully established itself in Cahora Bassa. No fishery has as yet developed for it; the nominal catch at present consists largely of *Hydrocynus*, *Distichodus*, *Clarias* and other table fish species.
Total annual catch: 4 343 t (estimate for 1982)
Potential annual yield: 8 000 t
(30 kg/ha/yr - Bernacsek & Lopes, 1984; Marshall, 1984a)
Productivity may be this low because of the heavy clay load in the water which reduces light penetration and may inhibit primary production (Gliwicz, 1984).

Specific reference: Gliwicz, 1984; Bernacsek & Lopes, 1984; Vostradovsky, 1984

CHICAMBA REAL RESERVOIR

Geographical data

Location: Mozambique - 19° 09'S; 33° 07'E
Surface area: 120 km^2
Max. length: 29 km
Max. width: 5.5 km
Major inflowing river: Revue
Outflowing river: Revue

MASSINGIR RESERVOIR

Geographical data

Location: Mozambique - 23° 53'S; 32° 09'E
Altitude: 109 m USL
Dam height: 30 m
Date closed: 1978
Surface area: 150.78 km^2 at USL
Depth: 70 m (max); 18.7 m (mean)
Volume: 2.8 km^3
Annual fluctuation in level: 6-7 m
Major inflowing rivers: Elephantes
Outflowing river: Elephantes

MASSINGIR RESERVOIR (cont.)

Physical and chemical data
Surface temperature: 25.2-25.9° C
Conductivity: 230-245 µS/cm
pH: 8.5

Fisheries data
No. of fishermen: 70 (1981)
No. of boats: 18 (1981)
Total annual catch: circa 400 t (1981)

PEQUENOS LIBOMBOS RESERVOIR

Geographical data
Location: Mozambique - 26° 02'S; 32° 26'E
Surface area: 47 km^2 at USL (16 km^2 min)
Depth: 10 m mean at USL (6 m mean at drawdown)
Major inflowing rivers: Umbeluzi, Calichane
Outflowing river: Umbeluzi

BABATILENE LAGOON

Geographical data
Location: Mozambique
Surface area: 0.5 km^2

BILENE LAGOON COMPLEX

Geographical data
Location: Mozambique - 25° 11'-27'S; 32° 58'-33° 26'E
Surface area: 55 km^2 combined
Special features: a complex of lagoons situated south of the Limpopo River consisting of five main lagoons: Uembje (21.7 km^2); Nhacheundezo (4.9 km^2); Muandeje (14.7 km^2); Pati (12.6 km^2) and Sane, plus several smaller lagoons.

BUMBE LAGOON

Geographical data
Location: Mozambique
Surface area: 0.55 km^2

BUTI LAGOON

Geographical data
Location: Mozambique
Surface area: 1 km^2

CHAGUEFULA LAGOON

Geographical data
Location: Mozambique
Surface area: 0.5 km^2

CHANGUE LAGOON

Geographical data
Location: Mozambique
Surface area: 0.8 km^2

CHOMBONHANE LAGOON

Geographical data
Location: Mozambique
Surface area: 1.5 km^2

FUNGUENE LAGOON

Geographical data
Location: Mozambique
Surface area: 3.5 km^2

INHASSORO LAGOON

Geographical data
Location: Mozambique - 21° 37'S; 35° 14'E
Surface area: 15 km^2
Max. length: 11 km
Max. width: 3 km

MACHANE LAGOON

Geographical data
Location: Mozambique
Surface area: 3 km^2

MACUMBE LAGOON

Geographical data
Location: Mozambique
Surface area: 1.5 km^2

MACUMLINE LAGOON

Geographical data
Location: Mozambique
Surface area: 0.6 km^2

MADACANINE LAGOON

Geographical data
Location: Mozambique
Surface area: 1 km^2

MAHANSE LAGOON

Geographical data
Location: Mozambique
Surface area: 1.30 km^2

MAMBEZE LAGOON

Geographical data
Location: Mozambique
Surface area: 2 km^2

MANDJENE (= PANDJENE) LAGOON

Geographical data
Location: Mozambique
Surface area: 10 km^2

MANGALIDJE LAGOON

Geographical data
Location: Mozambique
Surface area: 1.2 km^2

MASSANGUANE LAGOON

Geographical data
Location: Mozambique
Surface area: 0.5 km^2

MATIBE LAGOON

Geographical data
Location: Mozambique
Surface area: 1.15 km^2

MUNDE (= MAUNDO) LAGOON

Geographical data
Location: Mozambique
Surface area: 7 km^2

NELA LAGOON

Geographical data
Location: Mozambique
Surface area: 0.85 km^2

NHAMANENE LAGOON COMPLEX

Geographical data
Location: Mozambique - 22° 15'-38'S; 35° 25'-32'E
Surface area: combined area circa 50 km^2
Special features: a cluster of over 40 coastal lagoons varying from freshwater to brackishwater. Includes Nhamanene (12.6 km^2), Manhali (11.6 km^2), Zevane (7.0 km^2), Muanga (4.6 km^2), Nhalenhengue and Colotiva Lagoons.

PITI LAGOON

Geographical data
Location: Mozambique - 26° 34'S; 32° 53'E
Surface area: 32.5 km^2
Max. length: 12 km
Max. width: 4.5 km

QUISSICO LAGOON COMPLEX

Geographical data
Location: Mozambique - 24° 15'-25° 01'S; 33° 55'-35° 25'E
Surface area: combined area of 300 km^2
Depth: generally max of 5 m, but up to 20 m in Poelala
Major inflowing river: Inharrime
Outflow: to Indian Ocean
Salinity: (^{o}/oo) Massava Lagoon: 3-4; Quissico Lagoon: 4.3; Inhagotou Lagoon: 4.6; Canda Lagoon: 7.0
Special features: a complex of lagoons situated between the Inharrime and Limpopo Rivers, consisting of several minor and 20 larger lagoons:
Nhacucu, Poelala (90 km^2), Inhassengane, Mahune, Massava, Muhanze, Quissico, Nhambavale, Canda, Zangabade, Malembue, Nhanzingue, Magombene, Nhanvue, Nhambavale, Tomezoe, Nhanzume, Vanze, Muie and Valute.
Tomezoe Lagoon is heavily infested with aquatic vegetation.

SATINE (= SOTIBA) LAGOON

Geographical data
Location: Mozambique - 26° 45'S; 32° 51'E
Surface area: 7.5 km^2

SUGI LAGOON

Geographical data
Location: Mozambique
Surface area: 0.5 km^2

TZEMBEZANHE LAGOON

Geographical data
Location: Mozambique
Surface area: 3.5 km^2

XAMANE LAGOON

Geographical data
Location: Mozambique
Surface area: 0.7 km^2

XAVI (= CHAVI) LAGOON

Geographical data
Location: Mozambique
Surface area: 0.8 km^2

XINGUTE (= CHINGUTI) LAGOON

Geographical data
Location: Mozambique - 26° 33'S, 32° 49'E
Surface area: 17.5 km^2

ZUALI LAGOON

Geographical data
Location: Mozambique
Surface area: 2 km^2

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NAMIBIA

1. GEOGRAPHY AND CLIMATE

Namibia has a surface area of 823 290 km^2. The country is largely semi-arid plateau and desert.

The climate is hot and dry with highly restricted rainfall. The economy is based on mineral extraction.

2. HYDROGRAPHY (see Fig. 1)

2.1 Lakes

There are no permanent freshwater lakes of any significant size. Non-permanent is Lake Liamberi, associated with Linyanti swamp.

2.2 Rivers, Floodplains and Swamps

Four large rivers flow along Namibia's borders: the Zambezi, Orange, Cunene and Okavango/Cubango.

2.3 Reservoirs

There are several impoundments: Hardop, Avis, Goreangab, Naute, Van Rhyn, Daan Viljoen, Ondangua, Okatana and Oshikango (the latter three are "saucer" dams located on the flat Ovambo tableland).

2.4 Coastal Lagoons

There is only one important lagoon at Sandwich Habour.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

There is no aquaculture in Namibia (Vincke, 1989, pers.comm.)

3.2 Fish Production and per caput supply (see Table 1 on following page)

3.3 Inland catch range and potential yield

Total annual yield: No data available (except Table 1 and Lake Liamberi: 180 t in early 1980's).

Potential annual yield: No data available.

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Namibia, 1970-1987

		Nominal Domestic Production (t) 2/				Nominal Consumer Supply (kg/person) 2/			
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Marine capture	Total	Inland capture	Aqua-culture 3/	Marine capture 4/	Total 4/
1970	1 042	- 4/		20 000	20 000	- 4/			
1971	1 068	- 4/		18 600	18 600	- 4/			
1972	1 096	- 4/		30 000	30 000	- 4/			
1973	1 124	- 4/		709 700	709 700	- 4/			
1974	1 152	50 5/		840 376	840 426	0.04			
1975	1 182	50		760 825	760 875	0.04			
1976	1 213	50		574 424	574 474	0.04			
1977	1 245	50		404 095	404 145	0.04			
1978	1 278	50		412 638	412 688	0.04			
1979	1 313	50		351 080	351 130	0.04			
1980	1 349	50		252 562	252 612	0.04			
1981	1 386	50		278 549	278 599	0.04			
1982	1 425	50		233 489	233 539	0.04			
1983	1 465	100		364 628	364 728	0.07			
1984	1 507	100		186 981	187 081	0.07			
1985	1 550	100		185 420	185 520	0.06			
1986	1 596	100		201 202	201 302	0.06			
1987	1 643	150		519 368	519 518	0.09			

1/ Source: FAO

2/ Source: FAO Fisheries Department FISHDAB

Important note:

Inland capture: excluding export

Marine capture: export statistics not available.

The 1970-87 catch data for Namibia include most of the quantities caught by fishing craft flying the South African flag and landed in Lüderitz and Walvis Bay (Namibia). Most of these landings are utilized for reduction into fish meal, for export abroad and domestic use. No statistics are available to ascertain precisely what part of the marine capture is actually used for domestic consumption.

3/ No aquaculture in Namibia

4/ No data available

5/ 1974-1987 rough estimates for inland capture

4. STATE OF THE FISHERY

4.1 Yield

No statistical data available except for Lake Liamberi, but it seems likely that catches are only a small fraction of the potential.

4.2 Factors influencing yield

Low rainfall and also, undoubtedly, the unstable security situation.

4.3 Future development possibilities

Development of inland fisheries is likely, once national sovereignty and stable internal security have been achieved.

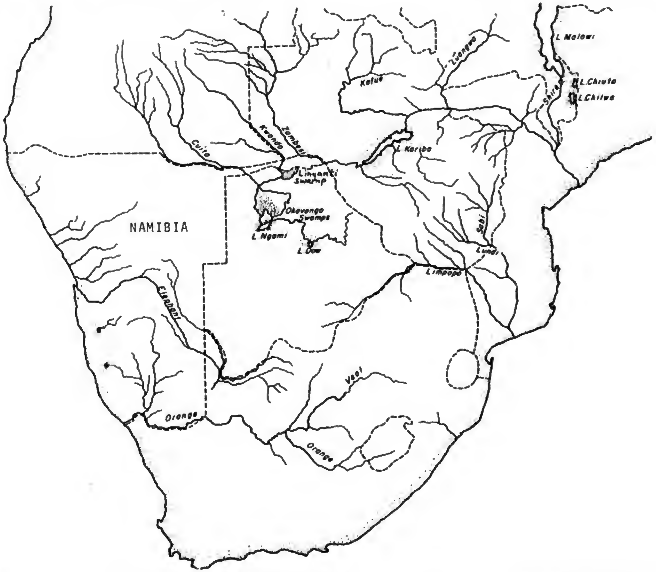

Fig. 1. RIVERS AND LAKES OF SOUTHERN AFRICA
(Welcomme, 1972)

5. KEY BIBLIOGRAPHY (none)

6. WATER BODIES DIRECTORY

Lake

Liamberi

Rivers

Cunene
Okavango/Cubango
Orange
Zambezi

Floodplain, Reservoir, Lagoon

Ovambo Floodplain, Linyanti Swamp
Hardap (Fish River) Reservoir
Sandwich Harbour Lagoon

LAKE LIAMBERI/LINYANTI SWAMP
(International water)

Geographical data (see Fig. 1)

Location: Botswana, Namibia -18°S; 24°20'E
Surface area: 101 km^2 (non-drought periods) (NORAD, 1985). Surface area very variable depending on annual flood inflow volume in any particular year; may dry out. Very little of its surface area lies in Botswana.
Inflowing river: Linyanti/Chobe
Outflowing river: Linyanti/Chobe

Fisheries data

No. of fish species: 43 (NORAD, 1985)
Total annual catch:
-about 800 t in the 1960's and early 1970's, most of it marketed in Zambia and Zimbabwe;
-no production in the late 1970's;
-about 180 t in the early 1980's (NORAD, 1985)
Potential annual yield:
For 101 km^2 open water: 250 t (25 kg/ha/yr: NORAD, 1985)

CUNENE RIVER
(International water)

Geographical data

Source: Central Angola (Bie Plateau)
Altitude: 1 800 m asl
Total length: 975 km
Drainage area: 83 000 km^2
Countries traversed: Angola, Namibia
Major tributaries: Calonga
Discharges to: Atlantic Ocean - 17° 15'S; 11° 46'E
Volume of discharge at mouth: 6.77 km^3/yr
Special features: In Angola, the Cunene is impounded at Matala (20-m-high dam), Kuene and Gove (58-m-high dam, 2 436 km^3 storage volume), and on the Calonga tributary north of Cassinga.

OKAVANGO/CUBANGO RIVER
(International water)

Geographical data (Welcomme, 1972)
Source: Bie Plateau, Angola
Altitude: 2 560 m asl
Countries traversed: Angola, Botswana, Namibia
Major tributaries: Cuito
Discharges to: The mouth of the Okavango splits into three main arms to form an internal delta which discharges into the Okavango Swamps. A further branch, the Thamalkane River, is connected to Lake Dow. A reversible and periodic connection exists between the Okavango and the Kwando/Cuando and Zambezi system. During the floods the Okavango sends surplus water to the Kwando/Cuando (or Chobe) River which, in turn, joins the Zambezi. If the Zambezi floods arise early, however, the process may be reversed.
Volume of discharge at mouth: 254 m^3/sec

ORANGE RIVER
(International water)

Geographical data (Welcomme, 1972)
Source: Lesotho, Drakensberg Mountains
Altitude: 3 300 m
Total length: 2 160 km
Drainage area: 640 000 km^2
Countries traversed: Lesotho, Namibia (north shoreline only), South Africa
Major tributaries: Vaal River (1 200 km)
Discharges to: South Atlantic
Flood regime: Floods between November and March
Special features: Aughrabies Falls

Physical and chemical data
Conductivity: K_{25} 159 µS/cm (mean) (Keulder, 1970)
pH: 7.7

ZAMBEZI RIVER
(International water)

Geographical data (Welcomme, 1972) (See map under "Mozambique Country" entry)
Source: northwest Zambia and eastern Angola
Altitude: 1 600 m
Total length: 2 574 km (120 km of shoreline along the Caprivi Strip belongs to Namibia)
Drainage area: 1 300 000 km^2
Countries traversed: Angola, Mozambique, Zambia, Botswana, Namibia, Zimbabwe
Major tributaries: Cuando, Kafue, Luangwa, Shire. The Zambezi system also communicates with the Okavango system via the Chobe River.
Discharges to: Indian Ocean - 18° 47'S; 36° E
Volume of discharge at mouth: 7 070 km^3/sec
Flood regime: December to July, maximum in March
Special features: Barotse floodplain (700-9 000 km^2), Kafue flats (200-7 000 km^2), Lukanga swamps (3 000-8 000 km^2), Kariba and Cahora Bassa dams/reservoirs.

ZAMBEZI RIVER (cont.)

Physical and chemical data above Lake Kariba (Coche, 1968)

		Flood	Low water
Temperature:		30° C	17° C
pH:		-	7.4
Conductivity:	K_{20}:	50 μS/cm	96 μS/cm
Total alkalinity:		20 mg/l	44 mg/l
Total hardness:		17.9 mg/l	38.1 mg/l
Ionic composition:		mg/l	mg/l
	Na	1.70	3.26
	K	-	0.88
	Ca	4.93	-
	Mg	1.47	3.86
	NO_2-N	0.00376	0.00024
	NO_3-N	0.0047	0.0158
	PO_4-P	0.0295	0.0078

Fisheries data

No. of fish species: Upper Zambezi: 49; Middle Zambezi: 50 (Jubb, 1961)

OVAMBO FLOODPLAIN

(International water)

Geographical data

Location: Angola, Namibia - 16°-18° S; 14° 50'-16° E

Surface area: 23 000 km^2 (15 000 km^2 in Angola; 8 000 km^2 in Namibia)

Major inflowing river: Cunene

Outflowing river: overspill and seepage to Etosha Pan.

HARDAP (= FISH RIVER) RESERVOIR

Geographical data

Location: Namibia - 24° 30'S; 17° 50'E

Surface area: 42.0 km^2

Max. length: 15 km

Max. width: 4 km

Major inflowing river: Fish

Outflowing river: Fish

SANDWICH HARBOUR LAGOON

Geographical data

Location: Namibia - 23° 22'S; 14° 29'E

Surface area: 22.1 km^2

Max. length: 10.5 km

Max. width: 3 km

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REUNION

1. GEOGRAPHY AND CLIMATE

Reunion (surface area of 2 500 km^2) is a mountainous island of volcanic origin. Coastal areas are forested. There are numerous torrential rivers. Maximum elevation is 3 069 m asl. The climate is tropical, but varies with altitude. Cyclones occur. The economy is based on agriculture, mainly sugar and flower oil.

2. HYDROGRAPHY

2.1 Lakes

There are no natural lakes of significant size.

2.2 Rivers, Floodplains and Swamps

There are numerous short torrential mountainous rivers.

2.3 Reservoirs

There are no large impoundments.

2.4 Coastal Lagoons

There are no lagoons.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

Inland and marine aquaculture are practised. (See Table 1)

Table 1. AQUACULTURE PRODUCTION BY SPECIES (t)

Species	1985*	1986	1987
Inland aquaculture			
Salmo gairdneri	12	14	15
Macrobrachium rosenbergii	4	6	7
Marine aquaculture			
Marine fishes	1	3	5
Chelonia mydas	30	50	-
Total	47	73	27

Source: Vincke, 1989 (pers.comm.)
* No data available for earlier years

3.2 Fish production and per caput supply (See Table 2)

Table 2. FISH PRODUCTION AND PER CAPUT SUPPLY - Reunion, 1970-1987

		Nominal Domestic Production (including exports) (t) 2/				Nominal Consumer Supply (including exports) (kg/person)			
Year	Population '000 1/	No inland capture	Aqua-culture 3/	Marine capture 5/	Total	No inland capture	Aqua-culture 3/	Marine capture 5/	Total
1970	441		- 4/	1 700	1 700		-	3.8	3.8
1971	449		-	2 200	2 200		-	4.9	4.9
1972	457		-	2 200	2 200		-	4.8	4.8
1973	465		-	2 500	2 500		-	5.4	5.4
1974	474		-	2 677	2 677		-	5.6	5.6
1975	482		-	2 213	2 213		-	4.6	4.6
1976	487		-	2 092	2 092		-	4.3	4.3
1977	493		-	779	779		-	1.6	1.6
1978	499		-	2 007	2 007		-	4.0	4.0
1979	504		-	2 482	2 482		-	4.9	4.9
1980	510		-	2 120	2 120		-	4.1	4.1
1981	514		-	3 573	3 573		-	6.9	6.9
1982	518		-	3 464	3 464		-	6.7	6.7
1983	522		-	3 025	3 025		-	5.8	5.8
1984	527		-	2 732	2 732		-	5.2	5.2
1985	531		16 6/	2 625	2 641		0.03	4.9	4.9
1986	539		20 6/	2 044	2 064		0.04	3.8	3.8
1987	547		22 6/	1 521	1 543		0.04	2.8	2.8

1/ Source: FAO
2/ Source: FAO Fisheries Department FISHDAB
3/ Inland aquaculture only
4/ - = data not available
5/ Marine exports were as follows:
1980: 114 t; 1981: 569 t; 1982: 894 t; 1983: 1 308 t.
6/ Vincke, 1989 (pers.comm.)

3.3 Inland catch range and potential yield

No data available for annual catch or potential yield for the main rivers: Bras de la Plaine, Langevin, Marsouins, Mat and Roches.

Total annual yield: Inland catch: 0 t; Inland aquaculture: 22 t (in 1987) (Vincke, 1989, pers.comm.).

4. STATE OF THE FISHERY

4.1 Yield

Capture fisheries are probably restricted to angling, but no catch data is available. There is some marine turtle and fish farming, as well as rainbow trout and *Macrobrachium* culturing. Production by species is given in Table 1.

4.2 Factors influencing yield

Generally, a lack of large surface water reserves. The high potential of marine fisheries does not encourage professional inland fisheries.

4.3 Future development possibilities

Undoubtedly some aquaculture development is possible; tilapia, trout and prawns have already been introduced to the island. Tilapia species in particular now occur in all river basins. The prospect for capture fisheries are, however, minimal.

5. KEY BIBLIOGRAPHY (none)

6. WATER BODIES DIRECTORY

Rivers

Bras de la Plaine
Langevin
Marsouins
Mat
Roches

BRAS DE LA PLAINE RIVER

Geographical data
Drainage area: 83 km^2
Countries traversed: Reunion
Discharges to: Indian Ocean
Volume of discharge at mouth: 6.09 m^3/sec (mean annual)
Flood regime: peak discharge in January (7.38 m^3/sec, monthly mean)

LANGEVIN RIVER

Geographical data
Drainage area: 36 km^2
Countries traversed: Reunion
Discharges to: Indian Ocean
Volume of discharge at mouth: 2.46 m^3/sec (mean annual)
Flood regime: peak discharge in January (3.62 m^3/sec, monthly mean)

MARSOUINS RIVER

Geographical data
Drainage area: 27.5 km^2
Countries traversed: Reunion
Discharges to: Indian Ocean
Volume of discharge at mouth: 5.29 m^3/sec (mean annual)
Flood regime: peak discharge in March (11.5 m^3/sec, monthly mean)

MAT RIVER

Geographical data
Drainage area: 145 km^2
Countries traversed: Reunion
Discharges to: Indian Ocean
Volume of discharge at mouth: 9.42 m^3/sec (mean annual)
Flood regime: peak discharge in March (14.7 m^3/sec, monthly mean)

ROCHES RIVER

Geographical data
Drainage area: 24.4 km^2
Countries traversed: Reunion
Discharges to: Indian Ocean
Volume of discharge at mouth: 4.18 m^3/sec (mean annual)
Flood regime: peak discharge in March (11.8 m^3/sec, monthly mean)

RWANDA

1. GEOGRAPHY AND CLIMATE (Welcomme, 1979a)

Rwanda has a surface area of 24 950 km^2 and consists mainly of grassy uplands which form part of the watershed between the Zaire and Nile River systems. It slopes from a range of high volcanoes in the northwest to savanna plains in the east. To the west the hills descend abruptly into Lake Kivu.

The high elevation makes for a temperate climate and frost may even occur in the high mountains. There is a short dry season in January with the major rainy season occurring from February to May. The main dry season lasts from May to September and the short rains from September to December. The rainfall is far heavier on the mountainous areas to the north and northwest than on the eastern savannas.

The population of Rwanda is entirely rural with small holdings dispersed throughout most of the country. Cattle herding is also very important although limited to the highlands because of heavy Tsetse infestations in the plains. There is one extensive national park along the lower portion of the Kagera River which contains many of the more important lowland lakes.

2. HYDROGRAPHY (see Fig. 1)

2.1 Lakes

Rwandan lakes fall into four main groups and into two main river basins:

(a) Lake Kivu, Zaire River Basin - very deep and rich in nutrients;

(b) High altitude lakes in the north (i.e. Lakes Luhondo and Bulera, the latter being associated with the Rugezi Swamps), Nile River Basin. These two lakes are cold, deep and rather infertile;

(c) Upper Akagera* Lakes Complex (i.e. Lakes Birira, Cyohoha South, Gaharwa, Gashanga, Kidogo, Kirimbi, Mirayi, Mugesera, Muhazi, Murago, Rugwero, Sake), Nile River Basin. Mean altitude: 1 360 m (except Muhazi; 1 450 m). These lakes are warm, shallow and fertile. They are interspaced among the flooded papyrus plain of the Akanyaru and the Nyabarongo Valleys. The combined surface area in Rwanda is 166.5 km^2;

(d) Lower Akagera Lakes Complex (i.e., Lakes Chuju, Hago, Ihema, Iwapibali (=Rwakibale), Kishanja, Kivumba, Mihindi, Nasho, Ngerenke, Muhari, Rwampanga, Rwanyakizinga, Rwehikama), Nile River Basin. Mean altitude: 1 200 m. These are warm, shallow and fertile. They are spread over the lateral floodplain of the Akagera River below the Rusumo Falls. The combined surface area is 178.4 km^2.

2.2 Rivers, Floodplains and Swamps

The country is dominated by the Akanyaru-Nyabarongo-Akagera River, which drains the majority of the country. The river is encased in narrow valleys for much of its upper course, but forms broad papyrus-filled swamps in its middle reaches. In its lower course, below the Rusumo Falls, it expands over large areas of savanna into a swamp mostly included in the Akagera National Park. The combined surface area of the Akagera swamps is about 1 000 km^2 in Rwanda. A higher altitude swamp occurs in the north of the country: Rugezi Swamp, 80 km^2, tributary of Lake Bulera. One other short but important river is the Ruzizi, which flows out of Lake Kivu toward Lake Tanganyika.

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* Also called "Kagera"

2.3 Reservoirs

Two reservoirs have been built, but are not used for fish production: Shyogwe reservoir near Gitarama (8.5 ha), drinking water reserve; and Nyabisundu reservoir near Bukare (7 ha), irrigation water reserve (Reizer, 1975).

2.4 Coastal Lagoons: None; Rwanda is landlocked.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

In the late 1950's total pond area was circa 450 ha. There were 2 662 ponds in 1978 with a combined area of 77.64 ha, an estimated production of 18 891 kg and an average yield of 243 fish/ha/yr. (Source: Ministère de l'Agriculture et de l'Elevage, Annual Report, 1978).

3.2 Fish production and per caput supply

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Rwanda, 1970-1987

Year	Population '000 1/	Nominal Domestic Production (excluding exports) (t) 2/			Nominal Consumer Supply (exluding imports and exports (kg/person)		
		Inland capture	Aqua-culture 2/ 3/	Total 2/	Inland capture	Aqua-culture 3/	Total
1970	3 718	1 500	- 4/	1 500	0.4	-	0.4
1971	3 838	1 600	-	1 600	0.4	-	0.4
1972	3 963	300	-	300	0.07	-	0.07
1973	4 091	800	-	800	0.2	-	0.2
1974	4 223	1 368	-	1 368	0.3	-	0.3
1975	4 360	1 198	-	1 198	0.3	-	0.3
1976	4 504	1 008	-	1 008	0.2	-	0.2
1977	4 654	1 325	-	1 325	0.3	-	0.3
1978	4 811	696	19 5/	715	0.1	0.004	0.1
1979	4 974	954	-	954	0.2	-	0.2
1980	5 144	1 181	19	1 200	0.2	0.004	0.2
1981	5 317	955	-	955	0.2	-	0.2
1982	5 496	1 210	-	1 210	0.2	-	0.2
1983	5 681	1 175	37	1 212	0.2	0.006	0.2
1984	5 872	744	42	786 7/	0.1	0.007	0.1
1985	6 070	851	55	906	0.1	0.009	0.1
1986	6 277	1 420	65	1 485 6/	0.2	0.010	0.2
1987	6 491	1 630	-	1 630	0.2	-	0.2

1/ Source: FAO

2/ Source: FAO Fisheries Department FISHDAB; see other sources data (bibliography) item 3.3.

3/ included in "Inland capture" if not specified

4/ - = data not available

5/ Source: Ministère de l'Agriculture et de l'Elevage, 1978

6/ Giudicelli et al., 1987: 1 800 t

7/ Ministère de l'Agriculture et de l'Elevage, 1985: 1 256 t in 1984

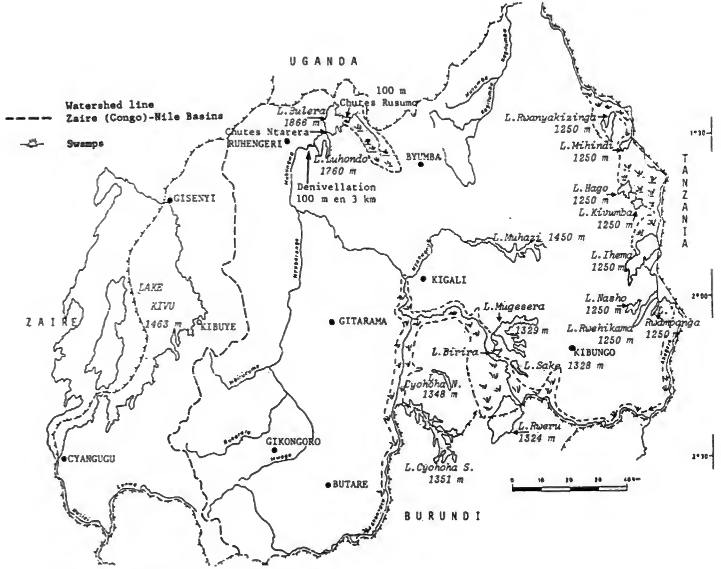

Fig. 1. RWANDA, HYDROGRAPHIC NETWORK
(adapted from Mahy, 1977)

3.3 Inland catch range and potential yield

Table 2.

Water body	Period	Annual catch range (t)	Potential annual yield (t)
Lake Kivu	1987	1 500-2 000	945-5 500
High altitude lakes	1975	100 1/	200 1/
Bilinga	-	-	-
Bulera	-	-	50
Karago	-	-	-
Luhondo	1974	50-100	50
Rugezi Swamp	-	-	10-120
Total		(100)	(110-220)
Upper Akagera Lakes	1975	1 200 1/	1 300 1/
Birira	1975	70	21-67
Cyohoha South	1975	40	70-225
Gaharwa	1975	10	9-29
Gashanga	1975	30	9-29
Kidogo	1975	40	9-28
Kirimbi	1975	20	14-42
Mirayi	1975	20	9-29
Mugesera	1975	300	156-490
Muhazi	1986	40	40-200
Murago	1975	10	9-27
Rugwero	1975	200	80-90
Sake	1975	180	178
Total		(960-1 200)	(774-1 594)
Lower Akagera Lakes	1975	650 1/2/	2 300 1/
*Chuju	-	-	1-2.5
*Hago	1975	90	64-210
*Ihema	1983	186	340-900
Iwapibali/Rwakibare	-	-	14-50
*Kishanja	-	-	3-9
*Kivumba	-	-	35-110
*Mihindi	-	-	44-140
*Muhari	-	-	2-7.5
Nasho	1975	50	55-160
*Ngerenke	-	-	5-20
*Rukira	-	-	2-6
Rwampanga	1975	30	38-110
*Rwanyakizinga	-	-	78-250
Rwehikama	1975	70	77-260
Total		(426-650)	(758-2 235)
Akagera Swamps	-	-	(4 000) 3/
Akagera River and tributaries		-	200
TOTAL (rounded)		3 000-3 950	2 600-9 650

1/ Aubray, 1976
2/ Reizer, 1975
3/ unaccessible; not in total
* Lakes located in Akagera National Park

4. STATE OF THE FISHERY

4.1 Yield

Present yield estimates vary from 1 630 t (Table 1) to 1 800 t (Giudicelli *et al.*, 1987), and 3 000-3 950 t (see table 2). An average current estimate of 2 500 t/yr seems reasonable.

4.2 Factors influencing yield

A variety of factors influence the yield of Rwandan inland waters. Lake Kivu traditionally has been a poor lake for fishing and, as a consequence, only the narrow coastal fringe has been exploited in a desultory manner (about 300 t of cichlids per year) (Welcomme, 1979a).

Now that *Limnothrissa miodon* has become established in Lake Kivu (yield about 1 900 t in 1987), an average total yield of about 2 000 t can be expected from the Rwandese waters of Lake Kivu.

The high altitude lakes (i.e. Bulera and Luhondo) and Upper Akagera Lakes Complex are fairly intensely exploited, although with proper management they could possibly sustain higher levels of catch. The Lower Akagera Lakes Complex was barely exploited because most of it lies within the game reserve and because of the lack of transport facilities in Rwanda (fish was caught mainly by Tanzanian fishermen in Lake Ihema). More recently, a development project in Lake Ihema allows fish catching and marketing to be effective in Rwanda (186 t in 1983; 400 t in 1986).

4.3 Future development possibilities

The fish catch from Rwanda could be increased, depending mainly on fisheries management. Although some authors estimate that Lake Kivu could yield up to about 5 500 t/yr for the Rwandan waters, a recent study, based on acoustic stock assessment surveys, estimates that the catchable *L. miodon* stock does not exceed 945 t in Rwanda.

Overfishing and destructive fishing methods have already considerably decreased production in the Upper Akagera Lakes and in those Lower Akagera Lakes not located in the National Park. Proper fisheries management and respect of fisheries regulations would significantly increase production. Dunn (1974) simply proposes a limit of 5 fishermen/km^2 for each lake and a catch limit of 12.5 t/km^2/yr.

The decision to officially open lakes located in the National Park to fishing activities must consider, on one hand, the estimated yield (1 730 t/yr) and, on the other hand, the damages that may arise in the National Park (Dunn, 1974).

No great increases can be anticipated for the high altitude lakes.

5. KEY BIBLIOGRAPHY

General: Aubray, 1976; Dunn, 1974; Mahy, 1977; Reizer, 1975
Lake Kivu: Hanek *et al.*, 1988
Akagera Basin: Burgis, Mavuti, Moreau and Moreau, 1987; Frank *et al.*, 1984; Kiss, 1977a,b

6. WATER BODIES DIRECTORY

Lakes

Bilinga
Birira
Bulera
Chuju
Cyohoha North
Cyohoha South
Gaharwa
Gashanga
Hago
Ihema
Iwapibali (= Rwapibale = Rwakibale = Rwakibare)
Karago
Kidogo*
Kirimbi
Kishanja (= Kisanji)
Kivu
Kivumba
Luhondo
Mihindi
Mirayi
Mugesera
Muhari
Muhazi (= Mohasi)
Murago (= Rumira)
Nasho
Ngerenke
Rugwero
Rukira
Rwampanga (= Mponga)
Rwanyakizinga (= Rwanye)
Rwehikama
Sake

Swamps

Akagera**
Rugezi (= Ruguesi)

Rivers

Akagera**
Ruzizi

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* Mistakenly called "Murago" on some official maps (Dunn, 1974)
** Also called "Kagera"

LAKE BILINGA

Geographical data
Location: Rwanda - 1° 37'S; 29° 32'E
Altitude: over 2 300 m
Surface area: 0.2 km^2
Max. length: 0.8 km
Max. width: 0.5 km
Outflowing river: none; internal basin

Fisheries data
Potential annual yield: High altitude, isolated lake. Production, if any, must be very low. No data available.

LAKE BIRIRA

Geographical data
Location: Rwanda (Upper Akagera Lakes Complex)
Surface area: 5.4 km^2
Depth: 6.0 m (mean)

Physical and chemical data (Kiss, 1976a)
Surface temperature: 25° C
Conductivity: 157 μS/cm
pH: 8.0

Fisheries data
No. of fishermen: 6 in 1973; recommended number: 27 (Dunn, 1974)
No. of boats: 6 in 1973
Total annual catch and effort: 70 t in 1975 (Reizer, 1975)
Potential annual yield: 21 t (40 kg/ha: Aubray, 1976)
67 t (125 kg/ha: Dunn, 1974)

LAKE BULERA

Geographical data

Location:	Rwanda - 1° 26'S; 29° 46'E
Altitude:	1 866 m
Surface area:	54 km^2
Depth:	174 m (max); 80 m (mean)
Max. length:	13 km
Max. width:	7 km
Volume:	4.5 km^3
Inflowing river:	Rusumu, Kabura
Outflowing river:	short channel to Lake Luhondo

Physical and chemical data (Damas, 1954)

Surface temperature: 19° C

Conductivity: 110 μS/cm

pH: 7.5; 8.2 (Mahy, 1977)

Oxygen: Surface: oversaturated
-160 m: 0.52 mg/l

Ionic composition:

	mg/l
Ca	7.1
Mg	3.9
Cl	0
SO_4	0

Fisheries data

Fish species: Main catches: *Oreochromis niloticus*, introduced in 1961

No. of fishermen: 85* (Reizer, 1975)

Total annual catch: 100 t* (Reizer, 1975)

Potential annual yield: For Lake Bulera: 50 t (10 kg/ha: Reizer, 1975)
*(for Lake Bulera+Lake Luhondo+Rugezi Swamp)

LAKE CHUJU

Geographical data

Location: Rwanda (Lower Akagera Lakes Complex)

Surface area: 0.2 km^2

Fisheries data

No. of fishermen recommended: 1 (Dunn, 1974)

Potential annual yield: 1 t (40 kg/ha: Aubray, 1976)
2.5 t (125 kg/ha: Dunn, 1974)

LAKE CYOHOHA NORTH

Geographical data

Location: Rwanda (Upper Akagera Lakes Complex)
No longer exists; dried out completely and is now cultivated area.

LAKE CYOHOHA SOUTH

(International water)

Geographical data

Location: Rwanda, Burundi - 2° 20'-2° 35'S; 29° 58'-30° 13'E
(Upper Kagera Lakes Complex)
Altitude: 1 380 m
Surface area: 76 km^2 (18 km^2 in Rwanda) (Kiss, 1977a)
Depth: 11 m (mean: 5.2 m) (Kiss, 1977a)
Volume: 395×10^6 m^3
Max. length: 32 km
Max. width: 2 km (Kiss, 1977a)
Shoreline: 227 km total; 63 km in Rwanda (Kiss, 1977a)
Note: Lake called "Cyohoha" in Burundi.

Physical and chemical data (Kiss, 1976a; 1977a)

Conductivity: K_{20} 250-256 µS/cm; 296 (surface); 319 (bottom) µS/cm
pH: 8.5-9.5 (surface); 7.2 (bottom)
Temperature: 23-27° C (surface)
Ionic composition:

	mg/l
Na	25.75
K	9.55
Ca	9.0
Mg	10.85
Cl	4.30
SiO_2	5.05
HCO_3	152-171 (surface-bottom)

Fisheries data

No. of fish species: 7: (3 *Oreochromis spp.*, 2 *Haplochromis spp.*, 1 *Synodontis sp.*, 1 *Clarias sp.*) (Kiss, 1977a)
No. of fishermen: 65 in Rwanda in 1973; 31 recommended (Dunn, 1974)
20 in Rwanda in 1975 (Kiss, 1977a)
50 in Lake in 1975 (Kiss, 1977a)
No. of boats: 65 in Rwanda in 1973
Total annual catch: in Rwanda: 90 t in 1968
40 t in 1973 (Dunn, 1974)
40 t in 1975 (Reizer, 1975)
20 t in 1975 (Kiss, 1977a)
in Lake: 60 t in 1975 (Kiss, 1977a)
Potential annual yield:
70 t in Rwanda (40 kg/ha: Aubray, 1976)
225 t in Rwanda (125 kg/ha: Dunn, 1974)

LAKE GAHARWA

Geographical data

Location: Rwanda (Upper Akagera Lakes Complex)
Surface area: 2.3 km^2
Depth: 2.0 m (mean)

Physical and chemical data (Kiss, 1976a)

Surface temperature: 25.0° C
Conductivity: 192 µS/cm
pH: 10.0

LAKE GAHARWA (cont.)

Fisheries data
No. of fishermen: 26 in 1973; recommended: 11 (Dunn, 1974)
No. of boats: 26 in 1973
Total annual catch: 59 t in 1968
10 t in 1973 - overexploitation (Dunn, 1974)
10 t in 1975 (Reizer, 1975)
Potential annual yield: 29 t (125 kg/ha: Dunn, 1974)
9 t (40 kg/ha: Aubray, 1976)

LAKE GASHANGA

Geographical data
Location: Rwanda (Upper Akagera Lakes Complex)
Surface area: 2.3 km^2
Depth: 3.0 m (mean)

Physical and chemical data (Kiss, 1976a)
Surface temperature: 26° C
Conductivity: 134 μS/cm
pH: 7.0

Fisheries data
No. of fishermen: 13 in 1973; recommended: 11 (Dunn, 1974)
No. of boats: 13 in 1973
Total annual catch:
30 t in 1973 (Dunn, 1974)
30 t in 1975 (Reizer, 1975)
Potential annual yield:
29 t (125 kg/ha: Dunn, 1974)
9 t (40 kg/ha: Aubray, 1976)

LAKE HAGO

Geographical data (Kiss, 1977a)
Location: Rwanda (Lower Akagera Lakes Complex), Akagera National Park
Surface area: 16.1 km^2
Depth: 5.8 m (max); 4.5 m (mean)
Max. length: 6.0 km
Max. width: 5.8 km
Volume: 45.2 x 10^6 m^3
Shoreline: 33.5 km

Physical and chemical data (Kiss, 1976a, 1977a)
Conductivity: 97 μS/cm (surface); 99 μS/cm (bottom)
pH: 8.92 (surface); 7.82 (bottom)
Ionic composition:

	mg/l	
	Surface	Bottom
Na	5.5	5.4
K		5.4
Cl	5.66	4.95
Ca	9.5	9
Mg	3.0	4.03
CO_3 + HCO_3	54.9	61.0
SiO_2	5.2	6
Fe++	0.45	0.70

LAKE HAGO (cont.)

Fisheries data
No. of fishermen: 6 in 1975-76 (Kiss, 1977); recommended: 80 (Dunn, 1974)
Total annual catch: 90 t in 1975-76 (Kiss, 1977a)
Potential annual yield:
210 t (130 kg/ha: Dunn, 1974)
64 t (40 kg/ha: Aubray, 1976)

LAKE IHEMA

Geographical data (Kiss, 1977)
Location: Rwanda (Lower Akagera Lakes Complex), Akagera National Park
Altitude: 1 291 m
Surface area: 86 km^2
Depth: 7 m (max); 4.8 m (mean)
Max. length: 22 km
Max. width: 7.8 km
Shoreline: 78 km
Volume: 512.6 x 10^6 m^3

Physical and chemical data (Kiss, 1976a, 1977b)

		Surface	Bottom
Temperature: °C		24.6-26.7	23.5
pH:		7.15	6.3
Oxygen: (saturation %)		105	8
Conductivity: (μS/cm)		110	103
Ionic composition:		mg/l	
	Na	5.9	3.9
	K	1.9	1.0
	Cl	8.8	7.8
	Ca	2.46	6.92
	Mg	3.9	5.4
	CO_3+HCO_3	42.7	
	SiO_2	6-9.2	6.7-9.2
	NO_2	0	0-0.3
	NH_4	0	0.03-0.5
	PO_4	0	0-0.03

Fisheries data
No. of fish species: 35 species in 9 families:
Cichlidae (11 sp), Mormyridae (7 sp), Characidae (3 sp),
Clariidae (2 sp), Cyprinidae (7 sp), Schilbeidae (1 sp),
Mochokidae (2 sp), Mastacembelidae (1 sp),
Ciprinodontidae (1 sp), (Frank *et al.*, 1984)
Main catches: Cichlidae (70%): mainly *Oreochromis niloticus* and *O. macrochir*;
Clariidae (25%): mainly *Clarias gariepinus* (Frank *et al.*, 1984)
No. of fishermen: 50 in 1968, 30 in 1970, 20 in 1971, 12 in 1972 (Kiss, 1977b)
42 (21 fishing units) in 1981
(Micha, quoted in Frank *et al.*, 1984)
360 recommended (Dunn, 1974)

LAKE IHEMA (cont.)

Fisheries data (cont.)

Total annual catch:

Year	Total catch (t)	
1968, 1969	450	
1970	180	
1972	75	(Kiss, 1977b: Tanzanian fishermen; decrease of catch due to increase of Rwandese watch on lake)
1981	168	(Frank et *al.*, 1984: catches from a fisheries development project)
1982	171	
1983	186	

Potential annual yield:

900 t = 1 200 t minus 300 t (predators) (Kiss, 1977b)
900 t (Dunn, 1974)
400 t (186 t for commercial species)
(Micha, quoted in Frank et *al*, 1984)
340 t (40 kg/ha: Aubray, 1976)

LAKE IWAPIBALI (= RWAPIBALE = RWAKIBALE = RWAKIBARE)

Geographical data (Kiss, 1977b)

Location:	Rwanda (Lower Akagera Lakes Complex), Akagera National Park
Surface area:	3.6 km^2
Depth:	6 m (max); 4.3 m (mean)
Max. length:	4 km
Max. width:	1.8 km
Shoreline:	9.5 km
Volume:	13.6 x 10^6 m^3

Physical and chemical data (Kiss, 1976a, 1977b)

		Surface	Bottom
Temperature: °C		23.7-26.8	22.7-23.6
Conductivity: (µS/cm)		107	
pH:		7.05	6.40
Ionic composition:		mg/l	
	Ca	5.12	3.64
	Mg	3.80	3.30
	Na	4.5	4.3
	K	1.8	1.3
	Fe++	0.4	0.8
	Cl	8.1	8.7
	CO_3-HCO_3	54.9	39.65
	SiO_2	8.4	8.4

Fisheries data

No. of fishermen: 4 in 1975/76 (Kiss, 1977a); 18 recommended (Dunn, 1974)

Potential annual catch:

50 t (138 kg/ha: Dunn, 1974)
14 t (40 kg/ha: Aubray, 1976)

LAKE KARAGO

Geographical data

Location: Rwanda - 1° 38'S; 29° 31'E

Altitude: over 2 300 m

Surface area: 0.3 km^2

Max. length: 1 km

Max. width: 0.5 km

Inflowing river: Nyamukongoro

Outflowing river: none; internal basin

Fisheries data

Potential annual yield: high altitude, isolated lake; production, if any, must be very low. No data available.

LAKE KIDOGO

Mistakenly called "MURAGO" on some official maps (Dunn, 1974)

Geographical data

Location: Rwanda (Upper Akagera Lakes Complex)

Surface area: 2.2 km^2

Depth: 3.0 m (mean)

Physical and chemical data

Surface temperature: 24.0° C

Conductivity: 129 µS/cm

pH: 6.5-7.0

Fisheries data

No. of fishermen: 8 in 1973; recommended: 11 (Dunn, 1974)

No. of boats: 8 in 1973

Total annual catch:

20 t in 1968 (Dunn, 1974)
40 t in 1973 (Dunn, 1974)
40 t in 1975 (Reizer, 1975)

Potential annual yield:

9 t (40 kg/ha: Aubray, 1976)
28 t (125 kg/ha: Dunn, 1974)

LAKE KIRIMBI

Geographical data

Location: Rwanda (Upper Akagera Lakes Complex)

Surface area: 3.4 km^2

Depth: 2.5 m (mean) (Kiss, 1976a)

Physical and chemical data (Kiss, 1976a)

Surface temperature: 24.0° C

Conductivity: 204 µS/cm

pH: 8.0

LAKE KIRIMBI (cont.)

Fisheries data

No. of fishermen: 15 in 1973; recommended: 11 (Dunn, 1974)
No. of boats: 15 in 1973
Total annual catch:
20 t in 1973 (Dunn, 1974)
20 t in 1975 (Reizer, 1975)
Potential annual yield:
14 t (40 kg/ha: Aubray, 1976)
42 t (125 kg/ha: Dunn, 1974)

LAKE KISHANJA (= KISANJI)

Geographical data

Location: Rwanda (Lower Akagera Lakes Complex)
Surface area: 0.7 km^2

Fisheries data

No. of fishermen: recommended: 4 (Dunn, 1974)
Potential annual yield:
3 t (40 kg/ha: Aubray, 1976)
9 t (125 kg/ha: Dunn, 1974)

LAKE KIVU

(International water)

see entry under country "ZAIRE"

LAKE KIVUMBA

Geographical data (Kiss, 1977b)

Location: Rwanda (Lower Akagera Lakes Complex), Akagera National Park
Surface area: 8.7 km^2
Depth: 5.6 m (max); 4.2 m (mean)
Max. length: 5.2 km
Max. width: 3.5 km
Volume: 30.3 x 10^6 m^3
Shoreline: 18.2 km

Physical and chemical data (Kiss, 1976a, 1977b)

		Surface	Bottom
pH:		9.15	6.70
Conductivity: (μS/cm)		103	100
Ionic composition:		mg/l	
	Ca	9.00	8.00
	Mg	2.7	3.3
	Na	5.4	5.2
	Fe++	0.55	0.8
	Cl	6.3	-
	CO_3-HCO_3	61.01	-
	SiO_2	8	8.5

LAKE KIVUMBA (cont.)

Fisheries data
No. of fishermen: 5 in 1975 (Kiss, 1977b)
46 recommended (Dunn, 1974)
Potential annual yield:
110 t (126 kg/ha: Dunn, 1974)
35 t (40 kg/ha: Aubray, 1976)

LAKE LUHONDO

Geographical data
Location: Rwanda - 1° 30'S; 29° 44'E
Altitude: 1 760 m
Surface area: 26.1 km^2
Depth: 68 m (max); 30 m (mean)
Max. length: 10 km
Max. width: 7 km
Volume: 1.0 km^3
Inflowing river: Gasura, outflow from Lake Bulera
Outflowing river: Mukungwa

Physical and chemical data (Damas, 1954)
Surface temperature: 20° C
Conductivity: 200 μS/cm
pH: 8.0
Oxygen: Surface: oversaturated
No oxygen in hypolimnion (-10 m), but not permanent, as water movement may occur (Mahy, 1977)
Ionic composition:

	mg/l
Ca	10.0
Mg	8.4
Cl	0
SO_4	0

Fisheries data
Main catches: *Oreochromis niloticus* (mainly); *Haplochromis* sp.
No. of fishermen: 55 in 1973 (Dunn, 1974)
85 (Lake Lahondo+Lake Bulera+Rugezi Swamp) (Reizer, 1975)
Total annual catch:
16 t in 1968
50-100 t (Dunn, 1974)
100 t in 1975 (Lake Luhondo+Lake Bulera+Rugezi Swamp) (Reizer, 1975; Aubray, 1976)
Potential annual yield: 50 t (20 kg/ha: Reizer, 1975)

LAKE MIHINDI

Geographical data (Kiss, 1977b)
Location: Rwanda (Lower Akagera Lakes Complex), Akagera National Park
Surface area: 10.9 km^2
Depth: 6.8 m (max); 4.4 m (mean)
Max. length: 4.2 km
Max. width: 3.9 km
Shoreline: 14.5 km
Volume: 41.8 x 10^6 m^3

LAKE MIHINDI (cont.)

Physical and chemical data (Kiss, 1976a; 1977b)
Temperature: 22.6-24° C
Conductivity: 97 µS/cm
pH: 7.10
Ionic composition:

	mg/l
Na	3.6
K	0.9
Ca	4.34
Mg	4.50
Cl	6.40
CO_3+HCO_3	39.65
Fe^{++}	0.9

Fisheries data
No. of fishermen: 8 in 1975 (Kiss, 1977b)
54 recommended (Dunn, 1974)
Potential annual yield:
140 t (128 kg/ha: Dunn, 1974)
44 t (40 kg/ha: Aubray, 1976)

LAKE MIRAYI

Geographical data
Location: Rwanda (Upper Akagera Lakes Complex)
Surface area: 2.3 km^2
Depth: 3.5 m (mean) (Kiss, 1976a)

Physical and chemical data (Kiss, 1976a)
Surface temperature: 25.5° C
Conductivity: 144 µS/cm
pH: 7.0

Fisheries data
No. of fishermen: 17 in 1973; recommended: 11 (Dunn, 1974)
No. of boats: 17 in 1973
Total annual catch:
20 t in 1973 (Dunn, 1974)
20 t in 1975 (Reizer, 1975)
Potential annual yield:
29 t (125 kg/ha: Dunn, 1974)
9 t (40 kg/ha: Aubray, 1976)

LAKE MUGESERA

Geographical data
Location: Rwanda (Upper Akagera Lakes Complex)
Altitude: 1 360 m
Surface area: 39 km^2 (Dunn, 1974)
Depth: 4.5 m (max); 3.0 m (mean)

Physical and chemical data (Kiss, 1976a)
Surface temperature: 23-25° C
pH: 9.1 surface; 7 bottom

LAKE MUGESERA (cont.)

Physical and chemical data (cont.)

Conductivity: 236 μS/cm
Total dissolved solids: 228 mg/l

Fisheries data

Fish species: (Mahy, 1977)
Fisheries interest: *Oreochromis niloticus, O. melanopleura*
Other: *Labeo victorianus, Haplochromis nubilus, Clarias carsonii, Mastacembelus taeniatus*
No. of fishermen: 325 in 1973; recommended: 196 (Dunn, 1974)
Total annual catch:
1964: 461 t (?)
1966: 130 t (Mahy, 1977)
1968: 35 t (?)
1973: 300 t (Dunn, 1974)
1975: 300 t (Reizer, 1975; Aubray, 1976)
Potential annual yield: 490 t (125 kg/ha: Dunn, 1974)
156 t (40 kg/ha: Aubray, 1976)

LAKE MUHARI

Geographical data

Location: Rwanda (Lower Akagera Lakes Complex), Akagera National Park
Surface area: 0.6 km^2 (Dunn, 1974)

Fisheries data

No. of fishermen: recommended: 3 (Dunn, 1974)
Potential annual yield:
7.5 t (125 kg/ha: Dunn, 1974)
2.4 t (40 kg/ha: Aubray, 1976)

LAKE MUHAZI (= MOHASI)

Geographical data

Location: Rwanda (Upper Akagera Lakes Complex)
Altitude: 1 450 m asl
Surface area: 34.1 km^2
Depth: 14 m (max); 10 m (mean)
Max. length: 37 km
Mean width: 0.6 km
Outflowing river: swamp (2 km) clogged, sometimes (every few years) opens under water pressure and discharges in Nyabugogo River.

Physical and chemical data (Frank, 1987)

Surface temperature: 23-24° C
Conductivity: annual mean: 502-528 μS/cm
pH: Surface: 8.7; bottom: 6.6; mean: 7.9
Oxygen: Surface: 6.8 mg/l (82% saturation)
-5 m: 2.0-2.7 mg/l (24-32%)
-10 m: 1.5 mg/l (18%)

LAKE MUHAZI (cont.)

Fisheries data

Fish species: 9 species: *Clarias spp., Haplochromis sp., Barbus sp., Oreochromis spp., Mastacembelus sp., Cyprinus sp.* (Frank, 1987)
Main catches: *Oreochromis niloticus, Clarias gariepinus*
Main fish predator: Otters (*Hydrictis maculicollis*)
consume 60 t fish/year (45 t *Oreochromis niloticus*)
(Frank, 1987)
No. of fishermen: (Frank, 1987)
in 1986: total 480 (professionals: 158 to 258);
recommended: 100 professionals (in 50 canoes)
Total annual catch:
260 t in 1955 (Mahy, 1977)
70 t in 1964 (Mahy, 1977)
50 t in 1975 (Reizer, 1975)
40 t in 1986 - decrease due to overfishing and destructive fishing methods (Frank, 1987)
Potential annual yield:
40 t at present;
If good fisheries management: 300 t minus predation:
200 t effective (Frank, 1987).
190 t (30 kg/ha: Reizer, 1975).

LAKE MURAGO (= RUMIRA)

Geographical data

Location: Rwanda (Upper Akagera Lakes Complex)
Surface area: 2.2 km^2
Depth: 3.0 m (mean)

Physical and chemical data (Kiss, 1976a)

Surface temperature: 25.0° C
Conductivity: 141 μS/cm
pH: 8.5-9.0

Fisheries data

No. of fishermen: 42 in 1973 (overexploitation);
11 recommended (Dunn, 1974)
No. of boats: 42 in 1973
Total annual catch: 10 t in 1975 (Reizer, 1975)
Potential annual yield:
27 t (125 kg/ha: Dunn, 1974)
9 t (40 kg/ha: Aubray, 1976)

LAKE NASHO

Geographical data (Kiss, 1977b)

Location: Rwanda (Lower Akagera Lakes Complex)
Surface area: 13.7 km^2
Depth: 6.3 m (max); 4.2 m (mean)
Max. length: 8.4 km
Max. width: 2.1 km
Shoreline: 27.8 km
Volume: 43×10^6 m^3

LAKE NASHO (cont.)

Fisheries data

No. of fishermen: 28 in 1975/76 (Kiss, 1977b)
65 recommended (Dunn, 1974)
Total annual catch:
50 t in 1975
150 t total in 3 lakes: Nasho, Rwampanga, Rwehikama (Reizer, 1975)
Potential annual yield:
160 t (116 kg/ha: Dunn, 1974)
55 t (40 kg/ha: Aubray, 1976)

LAKE NGERENKE

Geographical data

Location: Rwanda (Lower Akagera Lakes Complex)
Surface area: 1.3 km^2

Fisheries data

No. of fishermen: 6 recommended (Dunn, 1974)
Potential annual yield:
20 t (154 kg/ha: Dunn, 1974)
5 t (40 kg/ha: Aubray, 1976)

LAKE RUGWERO

(International water)

Geographical data (Kiss, 1977a)

Location: Rwanda, Burundi - 2° 21'-2° 27'S; 30° 17'-30° 24'E (Upper Akagera Lakes Complex)
Altitude: 1 350 m
Surface area: 100 km^2 (20 km^2 in Rwanda)
Depth: 3.9 m (max); 2.1 m (mean)
Volume: 210 x 10^6 m^3
Max. length: 18 km
Max. width: 14.5 km
Shoreline: 76 km

Physical and chemical data (Kiss, 1977a)

Conductivity: K_{25} 156 μS/cm (surface); 158 μS/cm (bottom)
pH: 8.80 (surface); 7.50 (bottom)
Temperature: 21.7-26.2° C
Oxygen: saturation: 120-150% (surface); 70-90% (bottom)
Ionic composition:

	mg/l
Na	13.40
K	6.35
Ca	4.40
Mg	6.07
Cl	5.40
SiO_2	37
HCO_3-CO_3	91.51

LAKE RUGWERO (cont.)

Fisheries data

No. of fish species: 17 in 4 families (Cichlidae, Cyprinidae, Clariidae, Mochokidae) (Kiss, 1977a)

No. of fishermen: in Rwanda: 130 in 1972
100 in 1973; recommended: 100 (Dunn, 1974)
in Lake: 150 in 1975/76; recommended: 200 (Kiss, 1977a)

Total annual catch:
in Rwanda: 260 t in 1968
232 t in 1972
250 t in 1973 (Dunn, 1974)
200 t in 1975 (Reizer, 1975; Aubray, 1976)
in Lake: 300 t in 1976 (Kiss, 1977a)
350-400 t (Corsi *et al.*, 1986)

Potential annual yield: limited because of the lack of beaches for reproduction of cichlids, and former overfishing (Kiss, 1977a)
in Rwanda: 80-90 t
in Lake: 400-450 t (Corsi et *al.*, 1986);

LAKE RUKIRA

Geographical data

Location: Rwanda (Lower Akagera Lakes Complex), Akagera National Park
Surface area: 0.5 km^2

Fisheries data

No. of fishermen: 2 recommended (Dunn, 1974)
Potential annual yield:
6.2 t (125 kg/ha: Dunn, 1974)
2 t (40 kg/ha: Aubray, 1976)

LAKE RUAMPANGA (= MPONGA)

Geographical data (Kiss, 1977b)

Location: Rwanda (Lower Akagera Lakes Complex)
Surface area: 9.5 km^2
Depth: 7.0 m (max); 5.2 m (mean)
Max. length: 7.0 km
Max. width: 2.2 km
Shoreline: 17.5 km
Volume: 32.6 x 10^6 m^3

Physical and chemical data (Kiss, 1976a; 1977b)

		Surface	Bottom
Temperature: °C		22-25	22-23
pH:		7.72	7.05
Conductivity: (µS/cm)		110	107
Ionic composition: (mg/l)			
	Na	5.2	4.5
	K	2.6	1.6
	Ca	5.16	5.24
	Mg	4.00	3.80
	Cl	7.90	8.10
	CO_3-HCO_3	48.81	45.57
	Fe++	0.60	0.90
	SiO_2	8.0	-

LAKE RWAMPANGA (cont.)

Fisheries data
No. of fishermen: 30 in 1975/76 (Kiss, 1977)
45 recommended (Dunn, 1974)
Total annual catch:
30 t in 1975
150 t total in 3 lakes: Rwampanga, Nasho, Rwehikama (Reizer, 1975)
Potential annual yield:
110 t (115 kg/ha: Dunn, 1974)
38 t (40 kg/ha: Aubray, 1976)

LAKE RWANYAKIZINGA (= RWANYE)

Geographical data (Kiss, 1977a)
Location: Rwanda (Lower Akagera Lakes Complex) Akagera National Park
Surface area: 19.6 km^2
Depth: 4.3 m (max); 2.6 m (mean)
Max. length: 10.3 km
Max. width: 4.3 km
Shoreline: 43.7 km
Volume: 42.3 x 10^6 m^3

Physical and chemical data (Kiss, 1977b)
Conductivity: 83 μS/cm
pH: 7.45
Ionic composition:
$CO_3 + HCO_3$: 51.85 mg/l

Fisheries data
No. of fishermen: 15 in 1975/76 (Kiss, 1977b)
100 recommended (Dunn, 1974)
Potential annual yield:
250 t (127 kg/ha: Dunn, 1974)
78 t (40 kg/ha: Aubray, 1976)

LAKE RWEHIKAMA

Geographical data (Kiss, 1977b)
Location: Rwanda (Lower Akagera Lakes Complex) Akagera National Park
Surface area: 19.2 km^2
Depth: 6.7 m (max); 4.1 m (mean)
Max. length: 14.0 km
Max. width: 3.1 km
Shoreline: 36.3 km
Volume: 51.4 x 10^6 m^3

Physical and chemical data (Kiss, 1977b)
Conductivity: 105 μS/cm
pH: 7.81 (surface); 7.00 (bottom)

LAKE RWEHIKAMA (cont.)

Physical and chemical data (cont.)

Ionic composition:

	mg/l
Ca	5.15
Mg	3.94
Na	4.8
K	2.1
Cl	7.95
CO_3+HCO_3	54.9

Fisheries data

No. of fishermen: 35 in 1975/76 (Kiss, 1977b)
105 recommended (Dunn, 1974)

Total annual catch:
70 t in 1975
150 t total in 3 lakes: Rwehikama, Nasho, Rwampanga (Reizer, 1975)

Potential annual yield:
260 t (135 kg/ha: Dunn, 1974)
77 t (40 kg/ha: Aubray, 1976)

LAKE SAKE

Geographical data

Location: Rwanda (Upper Akagera Lakes Complex)
Surface area: 14.3 km^2
Depth: 4.5 m (mean)

Physical and chemical data (Kiss, 1976a)

Surface temperature: 26.0° C
Conductivity: 182 μS/cm
pH: 8.0

Fisheries data

No. of fishermen: 100 in 1973; 71 recommended (Dunn, 1974)

Total annual catch:
13 t in 1968 (Dunn, 1974)
180 t in 1973 (Dunn, 1974)
180 t in 1975 (Reizer, 1975)
170 t in 1975 (Aubray, 1976)

Potential annual yield:
178 t (125 kg/ha: Dunn, 1974)

AKAGERA SWAMPS

(International water)

Geographical data

Location: Rwanda, Burundi, Tanzania, Akagera Lakes Complex
Altitude: 1 200-1 350 m
Surface area: 1 000 km^2 in Rwanda (Aubray, 1976)
Depth: 3 m (max); 2 m (mean) (Aubray, 1976)

Note: also called "Kagera"

AKAGERA SWAMPS (cont.)

Physical and chemical data (Aubray, 1976)
Surface temperature: 24.0° C
pH: 7 (mean)

Fisheries data
Potential annual yield:
4 000 t (40 kg/ha: Welcomme, 1989, pers.comm.)
The inaccessibility of the papyrus-filled swamps to the fishermen makes most of that yield unavailable.

RUGEZI (= RUGUESI) SWAMP

Geographical data
Location: Rwanda - 1° 30'S; 29° 52'E
Altitude: 1 950 m
Surface area: 80 km^2
Max. length: 25 km
Max. width: 4 km
Outflowing river: Rusumu (to Lake Bulera)

Physical and chemical data (Damas, 1954)
Surface temperature: 15° C
Conductivity: 40 µS/cm
pH: 5.3
Ionic composition: Ca, Mg - traces; Cl - 0; SO_4 - 0

Fisheries data
No. of fishermen: 85 (Rugezi Swamp+Lake Bulera+Lake Luhondo) (Reizer, 1975)
Total annual catch: 100 t (Rugezi Swamp+Lake Bulera+Lakd Luhondo) (Reizer, 1975)
Potential annual yield:
10 t (1 kg/ha: Reizer, 1975)
120 t (15 kg/ha for acid, low conductivity water: Welcomme, 1989, pers.comm.)

AKAGERA RIVER

(International water)

Geographical data
Source: Burundi/Rwanda
Total length: 785 km
Countries traversed: Burundi, Rwanda, Tanzania, Uganda
Major tributaries: Akanyaru, Nyabarongo
Discharges to: Lake Victoria
Note: also called "Kagera River"
Special features:

(1) Upper Akagera Lakes Complex: a group of lakes distributed as follows:
in Burundi: Ingitamo, Kacamurinda, Kanzigiri, Lirwihinda, Rungazi;
in Rwanda: Birira, Gaharwa, Gashanga, Kidogo, Kirimbi, Mirayi, Mugesera, Muhazi, Murago, Sake;
international waters (Burundi/Rwanda): Cyohoha South, Rugwero.

AKAGERA RIVER (cont.)

Geographical data (cont.)
Special features:

(2) Rusumo Falls: in Rwanda

(3) Lower Akagera Lakes Complex and Floodplain/Swamp: a group of lakes and adjacent floodplain/swamp. Lakes distributed as follows:
in Rwanda: Chuju, Hago, Ihema, Iwapibali, Kishanja, Kivumba, Mihindi, Muhari, Nasho, Ngerenke, Rukira, Rwakibare, Rwampanga, Rwanyaki Zinga, Rwehikama, Sekena;
in Tanzania: Bisongo, Kajumbura, Lwelo, Mujunju, Rushwa.
Floodplain/swamp area in Rwanda is circa 1 000 km^2.

Physical and chemical data (Kiss, 1977a)
Conductivity: K_{25} 111 μS/cm
pH: 7.01
Ionic composition:

	mg/l
Na	4.1
K	1.0
Ca	4.60
Mg	4.90
Cl	7.40
HCO_3-CO_3	42.70
Fe++	0.30

Fisheries data
Potential annual yield: 200 t in Rwanda (Aubray, 1976)

RUZIZI RIVER
(International water)

Geographical data
Source: Lake Kivu
Countries traversed: Burundi, Rwanda, Zaire
Discharges to: Lake Tanganyika

Physical and chemical data
Conductivity: upper course, K_{18} 1 190 μS/cm
lower course, K_{18} 828 μS/cm
Ionic composition:

	(Beauchamp, 1939) mg/l	(Dubois, 1958) mg/l
Na	94.8	98.0
K	63.0	74.0
Ca	8.4	8.5
Mg	67.0	101.6
Cl	23.8	16.6
SO_4	17.8	9.0
SiO_2	9.0-9.8	8.0
HCO_3+CO_3	638.1	585.6

7. BIBLIOGRAPHY

(except Lake Kivu: see ZAIRE)

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SEYCHELLES

1. GEOGRAPHY AND CLIMATE

Seychelles (with a surface area of 443 km^2) consists of an archipelago of over 100 islands, 46 of which are permanently inhabited. The islands are the high point of the north-south running granitic Mascarene Ridge of the Indian Ocean. The landscape is rugged, with small fertile hollows between rock relief.

The coast has an almost constant warm temperature of 27° C and high humidity. Temperatures are lower at higher altitudes. The economy is based on agriculture (chiefly copra) and tourism.

2. HYDROGRAPHY

2.1 **Lakes:** None of significant size

2.2 **Rivers, Floodplains and Swamps:** Only short streams

2.3 **Reservoirs:** A small reservoir (cascade) near the airport on Mahè Island

2.4 **Coastal Lagoons:** None

3. FISHERY PRODUCTION/POTENTIAL

3.1 **Aquaculture:** There is no aquaculture (Vincke, 1989, pers.comm.)

3.2 **Fish production and per caput supply:** See Table 1

3.3 **Inland catch range and potential yield:** None

4. STATE OF THE FISHERY

4.1 **Yield:** There appears to be no inland fishery.

4.2 **Factors influencing yield:** Lack of sizeable inland water bodies.

4.3 Future development possibilities

Some development in aquaculture may be possible, but inland fishery production may never become very important.

5. KEY BIBLIOGRAPHY (None)

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Seychelles 1970-1987

		Nominal Domestic Production (including exports) (t) 2/				Nominal Consumer Supply (including exports) (kg/person)			
Year	Population '000 1/	No inland capture	No Aqua-culture	Marine capture 3/	Total	No inland capture	No Aqua-culture	Marine capture 3/	Total
1970	52			2 000	2 000			38.4	38.4
1971	53			2 000	2 000			37.7	37.7
1972	54			2 500	2 500			46.3	46.3
1973	55			3 000	3 000			54.5	54.5
1974	57			3 500	3 500			61.4	61.4
1975	58			3 950	3 950			68.1	68.1
1976	59			4 010	4 010			68.0	68.0
1977	60			4 600	4 600			76.6	76.6
1978	62			5 400	5 400			87.1	87.1
1979	63			4 957	4 957			78.7	78.7
1980	65			4 676	4 676			71.9	71.9
1981	67			5 221	5 221			77.9	77.9
1982	69			4 045	4 045			58.6	58.6
1983	71			3 853	3 853			54.3	54.3
1984	74			3 831	3 831			51.8	51.8
1985	76			4 090	4 090			53.8	53.8
1986	79			4 542	4 542			57.5	57.5
1987	81			3 953	3 953			48.8	48.8

1/ Source: FAO

2/ Source: FAO Fisheries Department FISHDAB

3/ Marine exports were as follows:
1980: 677 t; 1981: 333 t; 1982: 619 t; 1983: 748 t

6. WATER BODIES DIRECTORY

Reservoir
Cascade

CASCADE RESERVOIR

Geographical data
Location: Seychelles (Mahè Island)

SWAZILAND

1. GEOGRAPHY AND CLIMATE

Swaziland has a surface area of 17 364 km^2. It consists of a highland plateau dipping to the south.

The climate varies from humid near-temperate in the highlands to almost tropical subhumid at lower elevations. Rainfall is concentrated into a few violent storms. The economy depends on commercial agriculture and mineral extraction.

2. HYDROGRAPHY (adapted from Chondoma, 1988) (See Fig. 1)

Swaziland is fairly rich in water resources, being traversed by five large rivers and with sufficient rainfall for rainfed agriculture in the highveld and middleveld. The water quality is generally good for fish farming.

Murdoch (1970), Tate and Lyle (1980), and USACE (1981) give the details of water quality parameters and their suitability to fish farming. Table 1 gives the summary of the water quality parameters (Chondoma, 1988).

Table 1. WATER QUALITY PARAMETERS

	Swaziland		Mbuluzi River at Fairview		Great Usutu at Sipafaneni
	Range	Mean	June	Feb.	
Dissolved solids (ppm)			39	223	135
Suspended solids (ppm)			8	189	-
Turbidity (FTU)	0-300	16	11	100	-
pH	6.1-8.9	7.2	7.4	7.8	7.0
Total alkalinity (ppm $CaCO_3$)	2-172	30	21	10	-
Total hardness (ppm $CaCO_3$)	30-200	40	43	40	32
Calcium (ppm Ca)			10.4	3.0	7
Magnesium (ppm Mg)			1.6	1.4	4
Chloride (ppm Cl)			1.1	5.0	10
C O D			12	-	-
Conductivity (μS/cm)			42	48	-

Sources: Murdoch (1970), Tate & Lyle (1980), and USACE (1981)

2.1 Lakes: None of significant size.

2.2 Rivers, Floodplains and Swamps

Swaziland is drained by five major rivers: the Mlumati, Nkomazi, Mbuluzi, Lusutfu and Ngwavuma. Of these, only two (the Mbuluzi and Ngwavuma) originate within Swaziland; the other three originate in South Africa (see Fig. 1). All these major rivers flow in an easterly direction, crossing the highveld, middleveld, lowveld and the Lubombo plateau, draining into the Indian Ocean.

Nearly all streams in the highveld are perennial, as opposed to the lowlands where most streams (except for the large rivers) flow only after large local storms. Even in those rivers which flow all year round, the discharge is markedly

Table 2: MAJOR DAMS AND THEIR PRIMARY USE
(Chondoma, 1988)

Dam	Surface area (ha)	Primary use	Potential annual yield (t) *
Mjoli	8 400	Sugarcane irrigation	168
Luphohlo	800	Hydroelectricity	16
Van Aeke	40	Sugarcane irrigation	0.8
Sand River	710	Irrigation	14.2
Hawane	150	Domestic	3
Sivunge	60	Irrigation	1-2
Nyetane	washed away	Irrigation, Fish hatchery	-
Total			203.2

* Based on SADCC (1984) estimate for a productivity of 20 kg/ha/yr. See also separate entries under section 6 and Table 4.

seasonal, depending on the rainfall in their catchment. A number of large dams (Table 2) have been built to store water and control the flow to irrigation schemes.

The total discharge as the rivers enter Swaziland is 60 m^3/s or 3.6 million litres per minute; the total discharge is 144 m^3/s or 8.6 million litres per minute when leaving Swaziland (Goudie & Williams, 1983; Murdoch, 1970). Figure 1 shows the major river basins and their mean discharge. However, water extraction, both in South Africa and Swaziland, increasingly decrease these values. Currently there is a tri-partite Joint Permanent Technical Committee (JPTC) between South Africa, Swaziland and Mozambique to regulate water releases from South Africa to Swaziland and from Swaziland to Mozambique.

Swaziland has no natural lakes, swamps or floodplain areas of economic importance.

2.3 Reservoirs

During the past 20-30 years a number of dams and reservoirs have been built for irrigation, community water supply, animal drinking and power generation. The dams and reservoirs range in size from a few large constructions, such as Mojoli Dam (8 400 ha), through many medium-sized reservoirs of 40-100 ha, to a large number of small reservoirs of 0.5-2 ha. Table 2 shows some of the major dams, their sizes and primary use. Most of these reservoirs and dams have been stocked with fish and some could support small-scale capture fishery or serve as foci for fish farming development.

2.4 Coastal Lagoons

None; Swaziland is landlocked.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture (adapted from Chondoma, 1988)

Swaziland's climate is favourable for fish farming, ranging from warm-water fish in the lowveld to cold-water fish in the upper reaches of the highveld.

There are no statistical records showing the national annual fish production from aquaculture. SADCC (1984) estimated that the total annual fish production in 1982 from aquaculture was about 50 tons, while the estimates of Vincke (1989, pers.comm.) are far lower (see Table 3).

There were about 500 family fish ponds in 1978. It was estimated that, in 1988, there were about 800 productive family ponds averaging between 100 and 200 m^2 in size, with an annual average production of 2 000 kg/ha. This estimate gives a productive total pond area of between 8 and 16 ha, producing between 16 and 32 tons. However, the exact location of most of these family fish ponds is not known for certain. In 1986 the Fisheries Section sampled and documented only 161 family fish ponds.

There are a few individuals and forest companies running small trout farms in the highveld; their production is also not known for certain.

Currently five fish species are successfully cultured: the rainbow trout (*Salmo gairdneri*), tilapia (*Tilapia rendalli* and *Oreochromis mossambicus*), sharp-toothed catfish (*Clarias gariepinus*) and the common carp (*Cyprinus carpio*). *C. carpio* and *S. gairdneri* are introduced species.

A number of factors limit the rate of aquaculture development in Swaziland. Among these are: the lack of trained manpower; lack of aquaculture policy and a development plan; and inadequate infrastructure, particularly for fish seed production.

Swaziland has a potential for aquaculture development, especially in the lowveld in integration with irrigation schemes. Given the climatic conditions, the development of infrastructure, and the current nutritional and socio-economic situation, aquaculture has a high chance of success in Swaziland. However, Swaziland will need long-term financial and technical assistance if aquaculture is to succeed.

3.2 Fish production and per caput supply

(See Table 3 on following page.)

3.3 Inland catch range and potential yield

No catch or potential yield figures are available for the major rivers: Komati, Lusutfu, Mbulugi, Mlumati and Ngwavuma.

Potential yield figures for reservoirs are given in Table 4.

Table 3. FISH PRODUCTION AND PER CAPUT SUPPLY - Swaziland, 1970-1987

		Nominal Domestic Production (excluding exports) (t) 2/			Nominal Consumer Supply (exluding imports and exports) (kg/person)		
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Total	Inland capture	Aqua-culture 3/	Total
1970	425	- 4/	-	-	-	-	-
1971	437	-	-	-	-	-	-
1972	448	-	-	-	-	-	-
1973	460	-	-	-	-	-	-
1974	471	-	-	-	-	-	-
1975	483	-	-	-	-	-	-
1976	497	-	-	-	-	-	-
1977	511	53	-	53	0.1	-	0.1
1978	526	44	-	44	0.08	-	0.08
1979	542	44	-	44	0.08	-	0.08
1980	559	44	-	44	0.08	-	0.08
1981	575	44	-	44	0.08	-	0.08
1982	592	44	-	44	0.07	-	0.07
1983	611	44	4 5/	48	0.07	0.006	0.08
1984	630	44	8 5/	52	0.07	0.01	0.08
1985	650	44	12 5/	56	0.07	0.02	0.09
1986	671	44	18 5/	62	0.06	0.03	0.09
1987	692	44	19 5/	63	0.06	0.03	0.09

1/ Source: FAO
2/ Source: FAO Fisheries Department FISHDAB; see also text (section 4) and Table 4.
3/ included in "Inland capture" if not specified
4/ - = data not available
5/ Vincke (1989, pers.comm.)

Table 4. POTENTIAL YIELD FOR RESERVOIRS

Reservoir	Period	Annual catch range (t)	Potential annual yield (t) 1/
Hawane	-	-	3
Lupholo	-	-	16
Mjoli	-	-	168
Mlilwane	-	-	0.1
Nyanteni	-	-	-
Pongolapoort	-	-	12
Sand River	-	-	14-80
Sivunge	-	-	1.2
Tobotsa	-	-	0.5
Van Aeke	-	-	0.8

1/ Sources: see text

Total annual yield:

Inland catch:	100 t in 1982 (SADCC, 1984)
	44 t (1978-1987) (FAO Fisheries Statistics)
Aquaculture:	50 t in 1982 (SADCC, 1984)
	19 t in 1987 (Vincke, 1989, pers.comm.)

Potential annual yield: (excluding rivers)
215-280 t (Table 4)
200 t (SADCC, 1984)

4. STATE OF THE FISHERY (adapted from Chondoma, 1988)

4.1 Yield

Swaziland does not have large natural lakes and, as a result, there is no capture fishery of any significance. Small-scale capture fishery has developed around the small man-made irrigation dams and reservoirs. The last estimated and reported catch from waters of Swaziland was 44 tons in 1987 (FAO, 1987). SADCC (1984) estimates the current catch to be 100 tons annually and 50 tons from aquaculture. This may be an overestimate of current catch as there has been a decrease in the number of fishing groups in recent years.

4.2 Factors influencing yield

Swaziland does not have natural lakes nor large man-made lakes to develop a major inland capture fishery. However, there are a number of small- to medium-sized dams and reservoirs which could develop small capture fisheries. The development of capture fishery in these small water bodies has been one of the main aims of the fishery development in Swaziland.

4.3 Future development possibilities

There is no reliable estimate of the potential production from the small water bodies and rivers in Swaziland. Clay (1972) estimated that production from the small water bodies could range between 20 and 150 kg/ha/yr, depending on the conditions of the dam; Clay also estimated that Sand River Dam (about 700 ha) alone could produce 80-150 t/yr. SADCC (1984) estimates the annual potential production from inland waters of Swaziland to be 200 tons, excluding aquaculture. These dams are primarily used for irrigation and are subject to considerable water level fluctuations. Even when these fluctuations are taken into consideration, SADCC's estimate of 200 t/yr works out to about 20 kg/ha/yr, if only the area of the major dams (Table 2) is used. Thus the real potential production may be higher than this estimate (see Table 4).

There is no estimated potential for aquaculture production. However, it is possible to double the current estimated annual production of 50 tons by improving the fish farming systems and utilizing new water bodies within the existing water use pattern. Therefore, increase in fish production will have to come also from aquaculture.

5. KEY BIBLIOGRAPHY

Chondoma, 1988

6. WATER BODIES DIRECTORY

Rivers

Komati

Reservoirs

Hawane
Lupholo
Mjoli
Mlilwane
Nyanteni
Pongolapoort
Sand River
Sivunge
Tobotsa
Van Aeke

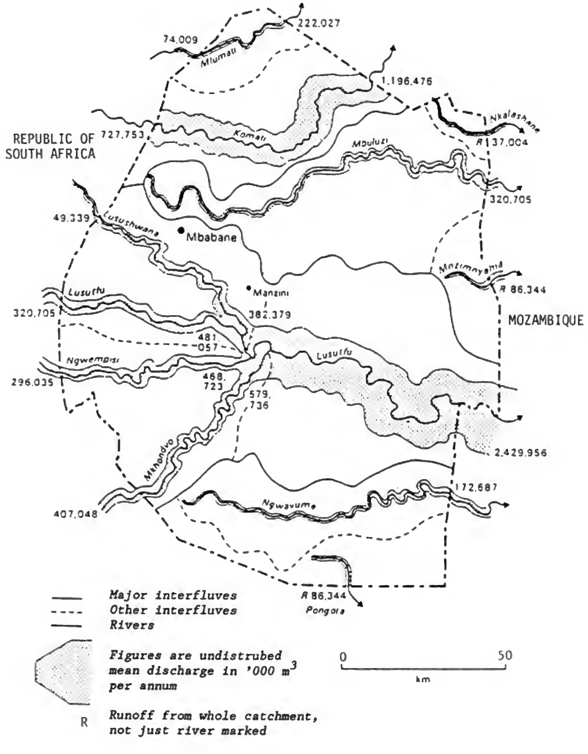

Fig. 1. RIVER BASINS AND THEIR DISCHARGE
(Goudie & Williams, 1983)

KOMATI RIVER
(International water)

Geographical data

Source:	near Breyten, South Africa
Altitude:	1 832 m
Total length:	714 km total (265 km in Mozambique; 95 km in Swaziland; 354 km in South Africa)
Drainage area:	46 246 km^2 total (14 925 km^2 in Mozambique; 2 500 km^2 in Swaziland; 28 821 km^2 in South Africa)
Countries traversed:	Mozambique, Swaziland, South Africa
Major tributaries:	Sabie, Crocodile
Discharges to:	Indian Ocean - 25° 49'S; 32° 44'E
Volume of discharge at mouth:	2.30 km^3
Flood regime:	Unimodal flood, peaking in January-February
Special features:	Several reservoirs, including Hartbeespoort and Sand River; floodplain in the lower course, including Lake Chuali (28.0 km^2) and several smaller lakes.

HAWANE RESERVOIR

Geographical data

Location:	Swaziland
Surface area:	1.50 km^2
Primary use:	domestic

Fisheries data

Potential annual yield: 3 t (20 kg/ha/yr: SADCC, 1984)

LUPHOLO RESERVOIR

Geographical data

Location:	Swaziland
Surface area:	8 km^2
Primary use:	hydroelectricity

Fisheries data

Potential annual yield: 16 t (20 kg/ha/yr: SADCC, 1984)

MJOLI RESERVOIR

Geographical data

Location:	Swaziland
Surface area:	84 km^2
Primary use:	sugarcane irrigation

Fisheries data

Potential annual yield: 168 t (20 kg/ha/yr: SADCC, 1984)

MLILWANE RESERVOIR

Geographical data
Location: Swaziland
Surface area: 0.06 km^2
Major inflowing river: tributary of Hlam

Fisheries data
Potential annual yield: 0.12 t (20 kg/ha/yr: SADCC, 1984)

NYANTENI RESERVOIR

Geographical data
Location: Swaziland
Surface area: 1.01 km^2 at USL (at present washed away)
Primary use: irrigation, fish hatchery

PONGOLAPOORT RESERVOIR

Geographical data
Location: Swaziland, South Africa - 27° 25'S; 31° 58'E
Altitude: 137 m asl at USL
Dam height: 69.8 m
Surface area: 132.74 km^2 at USL
(126.74 km^2 in South Africa; 6 km^2 in Swaziland)
Depth: 69.8 m (max); 18.8 m (mean)
Volume: 2.5006 km^3
Max. length: 25 km
Max. width: 5 km
Major inflowing rivers: Pongolo
Outflowing river: Pongolo

Fisheries data
Potential annual yield: 12 t (20 kg/ha/yr: SADCC, 1984)

SAND RIVER RESERVOIR

Geographical data
Location: Swaziland - 25° 59'S; 31° 43'E
Date closed: 1965
Surface area: 7.1 km^2 at USL; 2.55 km^2 (min)
Max. length: 4.5 km
Max. width: 2.5 km
Major inflowing rivers: pumped water from Komati River
Primary use: irrigation

Fisheries data
Potential annual yield: 14.2 t (20 kg/ha/yr: SADCC, 1984)
80-150 t (Clay, 1972)

SIVUNGE RESERVOIR

Geographical data

Location:	Swaziland
Surface area:	0.6 km^2
Primary use:	irrigation

Fisheries data

Potential annual yield: 1.2 t (20 kg/ha/yr: SADCC, 1984)

TOBOTSA RESERVOIR

Geographical data

Location:	Swaziland
Surface area:	0.28 km^2

Fisheries data

Potential annual yield: 0.56 t (20 kg/ha/yr: SADCC, 1984)

VAN AEKE RESERVOIR

Geographical data

Location:	Swaziland
Surface area:	0.4 km^2
Primary use:	sugarcane irrigation

Fisheries data

Potential annual yield: 0.8 t (20 kg/ha/yr: SADCC, 1984)

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7. BIBLIOGRAPHY

Chondoma, 1988
Clay, 1972
Goudie & Williams, 1983
Murdoch, 1970
SADCC, 1984
Tate & Lyle, 1980
USACE, 1981

TANZANIA

1. GEOGRAPHY AND CLIMATE (Welcomme, 1979a)

The topography of continental Tanzania (surface area of 886 040 km^2) (Fig. 1) is highly varied but four main types of terrain predominate:

(a) the coast, below 300 m altitude:
(b) the alluvial plains of the main eastward flowing rivers, from 300 to 1 000 m in altitude;
(c) an inland plateau which covers most of the country, 1-2 000 m; and
(d) highlands to the south and northeast, which range between 2 000 and 5 900 m. Parts of both eastern and western arms of the Rift Valley systems lie within Tanzania.

The climate is linked to the topography, having also four main areas:

(a) a hot humid coastal zone;
(b) a hot arid central area;
(c) high moist lake regions; and
(d) temperate uplands.

The overall climate is regulated by the monsoons which give two equinoctial rains, one from March to June, the other from October to December. At other times of the year the weather is hot and dry. Tanzania is a predominantly agricultural country, although some areas are used mainly for cattle ranching and game parks.

2. HYDROGRAPHY (Welcomme, 1979a; Balarin, 1985b)

2.1 Lakes (See Fig. 2)

Tanzania is extremely well endowed with lakes. The total water area in Tanzania covers nearly 61 500 km^2 or about 6.5% of the total land area, 88% of which is made up by three major lakes. The main lakes are shared with neighbouring countries and are generally associated with the Great Rift Valley. These include Lake Tanganyika and Lake Nyasa, both elongated and rather deep, and Lake Victoria, which is a broad and relatively shallow lake.

Almost half the areas of two of the Great Lakes (Victoria and Tanganyika) lie within Tanzania, while Tanzania possesses 800 km of shoreline on the third (Lake Malawi/Nyasa). Other large lakes include Lake Rukwa and Kitangiri and a group of Rift Valley soda lakes (Lakes Natron, Eyasi and Manyara) which are very shallow and liable to dry up in low rainfall periods.

Numerous smaller lakes are scattered throughout the country.

2.2 Rivers, Floodplains and Swamps (see Fig. 2)

There are comparatively few river systems within Tanzania as the main central plateau is arid. Four distinct river basins are apparent. The greater part of the eastern and southern regions are drained by rivers flowing to the Indian Ocean. These include one of the largest rivers in Africa, the Rufiji, with an average dis-charge of 1 133 m^3/sec, and minor rivers such as Pangani, Ruwami, Ruvu and the Lake Nyasa rivers. The remaining basins are associated with either Lake Victoria, Lake Tanganyika or the interior drainage including the Lake Rukwa Basin.

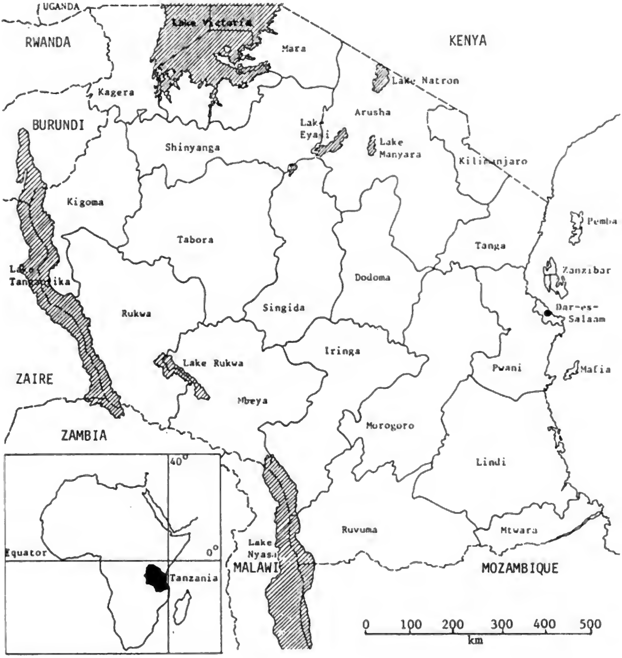
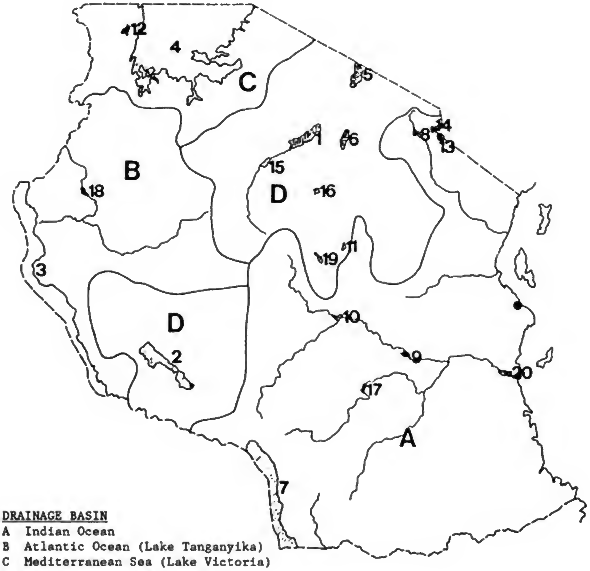


Fig. 1. LOCATION MAP AND ADMINISTRATIVE DIVISIONS OF TANZANIA
(Balarin, 1985b)



DRAINAGE BASIN
A Indian Ocean
B Atlantic Ocean (Lake Tanganyika)
C Mediterranean Sea (Lake Victoria)
D Interior drainage

NAME OF LAKE OR RESERVOIR (construction date)
1. Lake Eyasi
2. Lake Rukwa
3. Lake Tanganyika
4. Lake Victoria
5. Lake Natron
6. Lake Manyara
7. Lake Nyasa
8. Nyumba ya Mundu Dam (1945)
9. Kidatu Reservoir (1974)
10. Mtera Reservoir (1979)
11. Hombolo Reservoir
12. Lake Ikimba
13. Lake Jipe
14. Lake Chala
15. Lake Kitangiri
16. Lake Balangida
17. Kibasira Swamp
18. Malagarasi Swamp
19. Bahi Swamp
20. Rufiji Floodplain

Fig. 2. HYDROLOGICAL ZONES AND MAIN LAKES IN TANZANIA
(S.M.D., 1976)

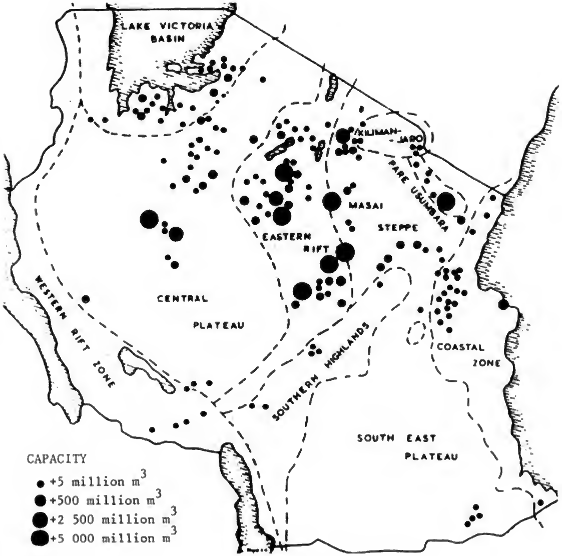


Fig. 3. THE DISTRIBUTION OF RESERVOIRS IN TANZANIA
(Bailey, 1966)

The Pangani River (360 km) drains the northern highlands and the 720 km Rufiji system drains the southern uplands. The Ruvuma River forms the border with Mozambique for 640 km. The other major river system, the Malagarasi, flows from the central plateau into Lake Tanganyika. The main channel is some 560 km long and expands into the Malagarasi Swamps. The Rufiji basin contains three important floodplains (Kilombero, Usanga and Rufiji). Important swamps include Malagarasi, Bahi and Kilosa.

Table 1. DISTRIBUTION OF RESERVOIRS IN TANZANIA
(Balarin, 1985)

Physical regions\ Admin. Districts with most reservoirs	Capacity ('000 m^3)				Surface area (ha)					Others no data	Total no.	Total stocked	Principal water-sheds
	5+	500+	2500+	5000	0.5+	5+	20+	40+	400+				
Coast													
Bagamoyo, Tanga	45	2	-	-	32	13	2	-	-	(?)	47	26	Ruvu, Wami, Pangani
Pare-Usambara													
Korogwe, Pare	9	1	-	1	7	2	-	1	1	-	11	6	Pangani
Kilimanjaro													
Kilimanjaro, Arusha	7	-	-	-	4	3	-	-	-	-	7	5	Pangani
Masai Steppe													
Masai	13	7	1	-	3	10	5	2	-	-	21	1	Masai
Eastern Rift													
Mbulu, Singida, Dodoma	24	8	3	6	13	9	7	9	3	12(+)	53	47	Rift Valley, Wami, Rufiji
Central Plateau													
Tabora, Nzega, Maswa, Shinyanga	35	7	2	1	12	20	5	7	1	155(+)	200	71	Malagarasi, Rift Valley
Lake Victoria Basin													
Musoma, Kwimba, Geita	45	3	-	-	30	15	3	-	-	38	86	56	Lake Victoria
Western Rift													
Mbeya, Rungwe	7	1	-	-	7	-	1	-	-	6(?)	14	8	Rukwa, Nyasa
Southern Highlands													
Iringa, Njombe	5	-	-	-	5	-	-	-	-	33(?)	38	8	Rufiji
Southeastern Plateau													
Nachingwea, Masasi	13	-	-	-	13	-	-	-	-	-(?)	13	9	Mbwemkuru, Ruvuma
Total	203	29	6	8	126	72	23	19	6	244	490	237	

Flow patterns vary with rainfall and rivers generally flow for 5-6 months of the year only, during the wet season. This condition is variable according to rainfall intensity; high altitude mountainous areas are more likely to have an all-year-round stream flow pattern.

2.3 Reservoirs (see Figs. 2, 3 and Table 1)

Water conservation dams have been constructed for domestic, livestock, irrigation or factory use, as well as flood control; in all cases these have been stocked with fish. Some of the earlier dam constructions are reviewed by Bailey (1966) and are summarized in Table 7 and Figure 9 according to the following categories:

large dams - over 5 million m^3;
medium dams - 2.5-5 million m^3;
small dams - 0.5-2.5 million m^3; and
minor dams - above 5 000 m^3.

In all, Bailey (1966) describes 490 dams, nearly 51% of which are less than 0.5 ha. Most of them are non-perennial, especially in the more arid regions. Most dams were built in the drier regions, in particular the eastern rift, the Masai Steppe and the western and central plateaus.

The Nyumba ya Mungu Reservoir was constructed on the Pangani River in 1965. A further reservoir, which will be larger than Nyumba ya Mungu, is planned at Stiegler's Gorge on the Rufiji River. There are two reservoirs (Mtera and Kidatu) on the Great Ruaha, a tributary of the Rufiji. Hombolo is a smaller impoundment on the Wami. There are also numerous small reservoirs which have been stocked with fish.

2.4 Coastal Lagoons: There are none of significant size.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

Some 10 000 ponds with a surface of 1 000 ha had been constructed by 1963, but because of poor technology and management many of these have since fallen into disuse.

In 1974, it was estimated that aquaculture production was about 1 800 t/yr with a forecasted rise to 80 000 t/yr by 1985 and 145 000 t/yr by 1995. In a more recent appraisal of the situation, FAO (1983b) considers that only about 800 ponds/reservoirs are still operational, yielding a low 130 kg/ha/yr. Several ponds are poorly managed, too shallow, lack proper water inlet/outlet, are overgrown or generally abandoned.

UNDP (1981) suggests that the fish yield of the 600-1 000 ponds believed functional in 1980 was no more than 8-13 t (i.e. 0.1 ha mean size at 130 kg/ha/yr). The latter is perhaps the most realistic estimate of total yield.

A good potential exists in Tanzania for the development of aquaculture in the large number of ponds already constructed, in several hundreds of water storage reservoirs, and in the development of the coastal belt through brackishwater aqua- culture. The stocking of small reservoirs, although initiated in various regions, still has not gained much momentum or any significant dimensions.

3.2 Fish production and per caput supply

Table 2. FISH PRODUCTION AND PER CAPUT SUPPLY - Tanzania, 1970-1987

		Nominal Domestic Production (excluding exports) (t) 2/				Nominal Consumer Supply (excluding imports and exports) (kg/person)			
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Marine capture	Total	Inland capture	Aqua-culture 3/	Marine capture	Total
1970	13 513	166 400	- 4/	18 600	185 000	12.3	-	1.4	13.7
1971	13 960	159 500	-	21 900	181 400	11.4	-	1.6	13.0
1972	14 421	128 000	-	28 900	156 900	8.9	-	2.0	10.9
1973	14 898	144 700	-	23 000	167 700	9.7	-	1.5	11.2
1974	15 391	142 617	-	28 283	170 900	9.3	-	1.8	11.1
1975	15 900	160 366	-	35 265	195 631	10.1	-	2.2	12.3
1976	16 445	190 784	-	48 491	239 275	11.6	-	2.9	14.5
1977	17 013	223 872	-	46 995	270 867	13.1	-	2.8	15.9
1978	17 607	163 775	-	47 323	211 098	9.3	-	2.7	12.0
1979	18 225	146 443	-	34 190	180 633	8.0	-	1.9	9.9
1980	18 867	189 900	-	37 994	227 894	10.1	-	2.0	12.1
1981	19 535	191 760	-	38 913	230 673	9.8	-	2.0	11.8
1982	20 230	200 728	13 5/	27 038	227 779	9.9	0.0006	1.3	11.2
1983	20 954	205 699	8 5/	33 478	239 185	9.8	0.0004	1.6	11.4
1984	21 710	237 303	15 5/	39 969	277 287	10.9	0.0007	1.8	12.7
1985	22 499	257 883	21 5/	42 740	300 644	11.4	0.0009	1.9	13.3
1986	23 334	265 738	32 5/	44 085	309 855	11.4	0.001	1.9	13.3
1987	24 201	265 735	35 5/	47 775	313 545	11.0	0.001	1.9	12.9

1/ Source: FAO

2/ Source: FAO Fisheries Statistics (see note below) (see also section 3.3)
Note: Recent report on Tanzania catch reporting system indicates need to revise raising factors. Total catch probably overestimated. (FAO Yearbook 1986 vol. 62)

3/ included in "Inland capture" if not specified

4/ - = data not available

5/ Vincke, 1989, pers.comm.

3.3 Inland catch range and potential yield

Table 3.

Water body	Period	Annual catch range (t) *	Potential annual yield (t) *
Lakes			
Babati	1979	48	-
Basuto	1978	16	-
Burigi	1976	25	-
Gombo	1979	77	-
Haubi	1978	3	-
Ikimba	1976	5	-
Kagera Complex (e)	Avg.	2 000 (a)	-
Kindai	1974	33	-
Kitangiri	1987	40 (a)	1 000
Manyara	1974	172	-

Table 3. (cont.)

Water body	Period	Annual catch range (t) *	Potential annual yield (t) *
Lakes (cont.)			
Mujunju (e)	1975	370	-
Nyasa	1986-88	10 000-15 000 (a)	15 000-100 000
Rukwa	1986	5 990 (a)	3 000
Rutamba	1987	32 (a)	-
Singida	1972	113	-
Tanganyika	1986-88	25 000 (a)	100 000
Tlawi	1978-79	1	-
Victoria	1986-88	150 000 (a)	63 000-100 000
Rivers/Swamps/Floodplains			
Bahi Swamp	1979	266	-
Bubu River	1979	71	-
Great Ruaha River and Usanga Floodplain	1987	392 (a)(c)	-
Kilombero River and Floodplain	1986-87	829 (a)(d)	-
Kilosa Swamp	1974	90	-
Malagarasi River/Swamp	1987	238 (a)	-
Rufiji River & Floodplain	1971	2 700 (a)	-
Ruvuma River	Avg.	2 000 (a)	
Ugalla River/Swamp	Avg.	200 (a)	-
Wami River	1979	47	-
Reservoirs			
Buigiri	1977	7	-
Chamwale	1963	3	-
Chibumagwe	1978	34	-
Dabalo	1979	7	-
Hombolo	1979	114	-
Igundu	1978	4	-
Ikowa	1979	7	-
Kerenge	1963	11	-
Kisaki	1979	29	-
Magindu	1963	0.2	-
Malya	1978	13	-
Mgori	1978	15	-
Mianji	1978	13	-
Mlowa	1979	6	-
Mtera	1986	3 254 (a)(b)	-
Myombo	1963	1	-
Ngwazi	1978	40	-
Nhumbu	1957	9	-
Nondwa	1979	25	-
Nyumba Ya Mungu	1987	4 300 (a)	4 500
Shishiyu	1978	1	-
Usiulize	1978	14	-
Other Minor Fisheries	1986-1988	5 000-10 000 (a)	40 000-50 000 (f)

(see footnotes on following page)

Footnotes to Table 3

* See main text for information sources used.
(a) Combination of official and other estimates, as quoted in Reynolds, 1989.
(b) Mtera also includes Ruaha River and other waters in Dodoma Region.
(c) Covers Mbeya Region section of Ruaha River.
(d) Includes also those sections of Ruaha, Wami, Ngerengere, Luhombero, Mkata, and Manyera Rivers flowing within or through Morogoro Region.
(e) Kagera Lakes Complex.
(f) Balarin (1985b), including the numerous swamps and minor lakes whose potential annual yield is not detailed in Table 3.

No data available for:
Lakes Ambussel, Bisongo/Ngoma (e), Burungi, Chala, Igalula, Ilamba, Jipe, Kajumbura (e), Kingili, Kitere, Magadi, Mamka, Mansi, Minyere, Mkoe, Ndutu, Nziwi, Rushwa, Sagara, Sekena (e), Welu;
Rivers Pangani, Ruvu, Songwe;
Reservoirs Eluanata, Geita, Igombe, Kalimawe, Kidatu, Manda, Mindutulieni, Muchlur, Mwetemo, Rwamkona.

Total annual yield: 211 975-221 975 t (combination of official and other estimates, as quoted in Reynolds, 1989)

Potential annual yield: 226 500-358 500 t

4. STATE OF THE FISHERY

4.1 Yield

Freshwater fish account for over 85% of total landings. The more common species include *Lates*, *Limnothrissa*, *Stolothrissa* (or dagaa), tilapia, *Clarias*, *Haplochromis*, *Bagrus* and *Labeo*. Estimated yield potential ranges between 220 000 and 360 000 tons per year (Table 3).

Tanzania has over 61 500 km^2 of inland waters, including numerous lakes and rivers, of which Lakes Victoria, Tanganyika and Nyasa provide the majority of the catch.

The yield from Lake Victoria has increased from 46 000 t/yr in 1975 to 99 000 t/yr in 1985, with a corresponding increase in catch per unit of effort. *Haplochromis* made up 35% of the catch in 1975 but reduced to 12% in 1985, while Nile perch has been increasing in importance (0% in 1975; 38% in 1985). However, it is anticipated that the Nile Perch population will begin to decrease as the *Haplochromis* stocks become depleted. Potential MSY has been estimated at 63 000-100 000 t/yr (Table 3) but FAO (1984) suggested that the lower value was a more realistic figure.

Lake Tanganyika fish yield estimates for 1983-86 fluctuated between 100 000 t/yr (official estimate) and 250 000 t/yr (FAO estimate). In 1975, the official estimate was 64 000 t/yr. FAO (1984) suggested a 100 000 t/yr potential.

Lake Nyasa, of which about 300 km of shoreline border Tanzania, yielded 25 000 to 35 000 t/yr (official estimate) or 10 000-15 000 t/yr (other estimates) in 1986. The potential is not well defined and ranges from 15 000 to 100 000 t/yr (Table 3).

Other waters of significant fishery potential include Nyumba ya Mungu which, in 1970, recorded a 25 000 t/yr catch; its potential, however, is likely to be only 4 000-5 000 t/yr, which is closer to the most recent recorded yield: 4 300 t in 1987. Lake Rukwa yielded 6 000 t/yr in 1986 (official estimate), against a recommended potential yield of 3 000 t/yr (FAO, 1984). Numerous swamps and minor lakes add up to a potential of 40 000-50 000 t/yr.

4.2 Factors influencing yield

Whereas the fisheries mentioned above depend much on the development of a suitable infrastructure of commercial-scale fisheries, several other fisheries, particularly Lakes Rukwa and Kitangiri, are subject to large natural fluctuations in area. The case of the Nyumba ya Mungu Reservoir shows a production rise and subsequent fall which conform to the normal pattern for newly established reservoirs. The peak production of 28 500 t seems excessive for a body of water of this size, but the present yield is consistent with yield patterns for other reservoirs in Africa.

4.3 Future development possibilities

There is the possibility for catch increases from numerous inland water bodies of Tanzania. Apart from Lake Victoria (which seems to be in an unbalanced condition), Lake Tanganyika could theoretically sustain a much higher yield. For the third Great Lake (Lake Nyasa) it is not clear whether or not the present catch range is close to the maximum sustainable yield. Additional production may be anticipated from the Mtera Reservoir on the Great Ruaha River and from the numerous smaller reservoirs that have been stocked.

Further development of fish production is hoped for by the spread of aquaculture, where it is estimated that 2 000 t could be produced from existing ponds, and 10 000 t from expanding aquaculture in about 40 000 ha of small dams and reservoirs. Increases in production through aquaculture could obviously surpass this.

From the wide range of potential estimates proposed for Tanzanian inland waters fisheries, the actual knowledge of the resources appears to be very limited; further studies are necessary.

5. KEY BIBLIOGRAPHY

Balarin, 1985b

6. WATER BODIES DIRECTORY

Lakes

- Amboseli
- Ambussel
- Babati
- Balangida
- Balangida Lelu
- Basuto
- Bisongo (= Ngoma)
- Burigi
- Burungi
- Chala
- Empakai
- Eyasi
- Gombo
- Haubi
- Igalula
- Ikimba
- Ilamba
- Jipe
- Kajumbura
- Kindai
- Kingili
- Kitangiri
- Kitere
- Lwelo
- Magadi
- Magadi
- Mamka
- Mansi
- Manyara
- Minyere
- Mkoe
- Mujunju (= Rwakajunju)
- Natron
- Ndutu
- Nyasa/Malawi
- Nziwi
- Rukwa
- Rutamba
- Sagara
- Sekena
- Singida
- Tanganyika
- Tlawi
- Victoria
- Welu

Rivers/Swamps

Bubu River
Great Ruaha River
Kagera River
Kilombero River/Floodplain
Malagarasi River/Swamp
Pangani River
Rufiji River/Floodplain
Ruvu River
Ruvubu River
Ruvuma River/Floodplain
Songwe River
Wami River
Bahi Swamp
Kilosa Swamp

Reservoirs

Buigiri
Chamwale
Chibumagwe
Dabalo
Eluanata
Elysia
Geita
Hombolo
Igombe
Igundu
Ikowa
Kalimawe
Kerenge
Kidatu
Kisaki
Magindu
Malya
Manda
Mgori
Mianji
Mindutulieni
Mlowa
Mtera
Muchlur
Mwetemo
Myombo
Ngwazi
Nhumbu
Nondwa
Nyumba ya Mungu
Rwamkona
Shishiyu
Uchama
Usiulize

LAKE AMBOSELI

(International water)

Geographical data

Location: Kenya, Tanzania - 2° 32’-43’S; 37° 1’-14’E
Altitude: 1 140 m
Surface area: 189 km^2 (max) (Kenya: 177 km^2 Tanzania: 12 km^2)
Max. length: 30 km
Max. width: 9 km
Inflowing river: Namanga
Special features: Lake Amboseli is a seasonal water body.

LAKE AMBUSSEL

Geographical data

Location: Tanzania - 3° 56’S; 37° 16’E
Surface area: 19 km^2
Max. length: 6 km
Max. width: 4.5 km

LAKE BABATI

Geographical data

Location: Tanzania - 4° 17’S; 35° 43’E
Surface area: 21 km^2
Depth: 5 m (max)
Max. length: 10 km
Max. width: 3 km

Physical and chemical data

pH: 7.5
Cl: 25.5 mg/l
Total dissolved solids: 542 mg/l

LAKE BABATI (cont.)

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1961-62	-	30	5
1963-69	-	-	-
1970	944	156	67
1971	814	202	73
1972	468	95	74
1973	295	151	59
1974	255	139	49
1975	-	-	-
1976	835	186	148
1977	273	291	168
1978	17	264	124
1979	48	302	142

LAKE BALANGIDA

Geographical data

Location:	Tanzania - 4° 21'S; 35° 21'E
Surface area:	33 km^2
Max. length:	15.5 km
Max. width:	3 km
Special features:	highly alkaline

LAKE BALANGIDA LELU

Geographical data

Location:	Tanzania - 4° 40'S; 35° 14'E
Surface area:	47 km^2
Max. length:	15 km
Max. width:	4.5 km
Special features:	highly alkaline

LAKE BASUTO

Geographical data

Location:	Tanzania
Surface area:	2.6 km^2

Physical and chemical data

pH:	8.6
Cl:	130 mg/l
Total dissolved solids:	1 392 mg/l

LAKE BASUTO (cont.)

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1970	-	91	20
1971	478	112	30
1972	455	41	24
1973	388	57	10
1974	177	59	15
1975	-	-	-
1976	290	100	18
1977	35	34	5
1978	16	21	4

LAKE BISONGO (= NGOMA)

Geographical data

Location:	Tanzania (Kagera Lakes Complex)
Surface area:	22 km^2 (Kiss, 1977a)
Max. length:	14.5 km
Max. width:	4.8 km
Depth:	8.6 m (max); 5.3 m (mean)

Physical and chemical data (Kiss, 1976a; 1977a)

Conductivity:	101 (surface), 97 (bottom) μS/cm
pH:	8.4 (surface), 7.2 (bottom)

Ionic composition:

	mg/l
Ca	4.22
Mg	4.65
Cl	8.20
HCO_3+CO_3	54.9

LAKE BURIGI

Geographical data (Kiss, 1976b, 1977a)

Location:	Tanzania - 2° 0'-2° 15'S; 31° 10'-31° 20'E
Altitude:	1 150 m
Surface area:	186 km^2 (of which 56 km^2 are swamps)
Depth:	7.8 m (max); 4.6 m (mean)
Volume:	930 x 10^6 m^3
Max. length:	42 km
Max. width:	7 km
Shoreline:	227 km
Outflowing river:	Mwisa River to Kagera River

Physical and chemical data (Kiss, 1976a; 1977a)

Conductivity:	430 μS/cm
pH:	8.85 (surface) 8.35 (bottom)

LAKE BURIGI (cont.)

Physical and chemical data (cont.)

Ionic composition:

	mg/l
Na	40.0
K	19.5
Ca	20.7
Mg	16.7
HCO_3	289.8
Cl	9.45 (surface); 14.08 (bottom)
PO_4-P	8.0

Fisheries data (Kiss, 1976b; 1977a)
Fish species: only 4 recorded by Kiss: of fishing interest: *Protopterus aethiopicus* and *Clarias mossambicus*; of no fishing interest: *Oreochromis variabilis* and *Haplochromis nubilus*
No. of fishermen: 20 in 1975-76
Total annual catch: 25 t in 1975-76

LAKE BURUNGI

Geographical data
Location: Tanzania - 3° 52'S; 35° 53'E
Surface area: 38 km^2
Max. length: 11 km
Max. width: 5 km
Inflowing river: Tarangire
Outflowing river: none - internal basin

LAKE CHALA

(International water)

Geographical data
Location: Kenya, Tanzania - 3° 19'S; 37° 42'E
Surface area: 5.2 km^2 (Kenya: 2.6 km^2; Tanzania: 2.6 km^2)
Max. length: 4 km
Max. width: 3 km

LAKE EMPAKAI

Geographical data
Location: Tanzania
Surface area: 7.4 km^2
Max. length: 3.5 km
Max. width: 3 km
Special features: high altitude lake situated in Empakai Crater.

LAKE EYASI

Geographical data

Location:	Tanzania - 3° 20'-3° 50'S; 34° 45'-35° 20'E
Altitude:	1 117 m
Max. length:	75 km
Max. width:	15 km
Special features:	a soda lake of high salinity.

LAKE GOMBO

Geographical data

Location:	Tanzania - 6° 38'S; 36° 42'E
Surface area:	1.4 km^2
Max. length:	2 km
Max. width:	1 km
Outflowing river:	Gombo Mkondoa

Fisheries data

No. of fishermen:	14 (1979)
No. of boats:	18 (1979)
Total annual catch:	77 t in 1979

LAKE HAUBI

Geographical data

Location:	Tanzania

Fisheries data

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1976	1.7	4	1
1977	2.8	5	1
1978	3.1	4	2
1979	0.7	4	-

LAKE IGALULA

Geographical data

Location:	Tanzania
Surface area:	10.4 km^2

LAKE IKIMBA

Geographical data (Kiss, 1976b)

Location:	Tanzania - 1° 25'-1° 30'S; 31° 35'E
Altitude:	1 150 m
Surface area:	35.3 km^2
Depth:	4 m (max); 2.8 m (mean)
Volume:	99 x 10^6 m^3
Max. length:	6.1 km

LAKE IKIMBA (cont.)

Geographical data (cont.)
Max. width: 6.1 km
Shoreline: 27 k
Outflowing river: Ngono River: acts as runoff but is itself separated from the lake by a swampy zone almost as extensive as the lake.

Physical and chemical data (Kiss, 1976b)
Conductivity: K_{25} 77-79 µS/cm
pH: 7.89 (surface); 7.68 (bottom)
Temperature: 22-26° C
Ionic composition:

	mg/l
Na	4.4
K	2.3
Ca	4.28
Mg	2.82
HCO_3	48.8
Cl	2.45
SiO_2	4.8
NH_4-N	0.05
PO_4-P	4.5
Fe	0.5
NO_2-NO_3	not detectable
SO_4	not detectable

Fisheries data (Kiss, 1976b, 1977a)
Fish species: Only 4 recorded by Kiss: *Protopterus aethiopicus, Clarias mossambicus, Oreochromis variabilis, Haplochromis nubilus.* Physical condition of fish below all standards (minimum size, ecto- and endo-parasites).
No. of fishermen: 10 in 1975-76
Total annual catch: 5 t in 1975-76

LAKE ILAMBA

Geographical data
Location: Tanzania
Surface area: 8.1 km^2

LAKE JIPE

(International water)

Geographical data (Welcomme, 1972)
Location: Tanzania/Kenya - 3° 35'S; 37° 85'E
Altitude: 700 m
Surface area: 39 km^2 (total)
Max. length: 12 km
Max. width: 3 km
Inflowing river: Lumi

Physical and chemical data (Kilham, 1971)
Conductivity: K_{25} 618 µS/cm
Total alkalinity: $CaCo_3$ 437 mg/l

LAKE JIPE (cont.)

Physical and chemical data (cont.)
Ionic composition:

	mg/l
Na	170.0
K	11.0
Ca	7.6
Mg	20.2
Cl	54.0
SO_4	8.0
SiO_2	46.0

Fisheries data (FAO/UNDP, 1966)
Total annual catch and effort: 150 t (in 1965) in Kenya waters only
Potential annual yield: 300 t total lake

LAKE KAJUMBURA

Geographical data
Location: Tanzania (Kagera Lakes Complex)
Surface area: 0.5 km^2

LAKE KINDAI

Geographical data
Location: Tanzania - 4° 51'S; 34° 44'E
Surface area: 2.6 km^2
Max. length: 2.5 km
Max. width: 1.5 km

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1966	98	30	-
1968	141	34	17
1969	164	30	15
1970	157	37	15
1971	181	34	19
1972	38	34	19
1973	59	55	28
1974	33	22	20

LAKE KINGILI

Geographical data
Location: Tanzania
Surface area: 6.1 km^2

LAKE KITANGIRI

Geographical data (Welcomme, 1972)

Location: Tanzania
4° 00'-5° 00'S; 34° 10'-34° 25'E (including floodplain)
4° 00'-4° 10'S; 34° 10'-34° 14'E (Lake only)
Altitude: 800 m
Surface area: 1 200 km^2 (including floodplain)
105 km^2 (lake only, but varies seasonally)
Depth: 3-5 m
Max. length: 40 km
Max. width: 12 km
Annual fluctuation in level: 1-3 m
Major inflowing rivers: Wembere, Manonga
Outflowing river: Sibiti to Lake Eyasi

Physical and chemical data (Talling & Talling, 1965)

Conductivity: K_{20} 785 μS/cm
pH: 8.0-8.9
Dissolved solids: 404-432 mg/1
Ionic composition:

	mg/l
Na	155.0
K	4.8
Ca	24.1
Mg	6.7
Cl	64.0
SO_4	<5.0
SiO_2	34.5
HCO_3+CO_3	6.65 meq/l
Total P	1 020.0 μg/l

Fisheries data

No. of fish species: 20 (Mann, 1965)
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1970	4 113	317	235*
1971	11 498	296	280
1972	1 771	-	-
1973	467	68	71
1974	532	132	95
1975	704	136	-
1976	303	396	100
1977	205	129	108
1978	1 285	188	155
1987	40 (average)**		

* Welcomme, 1972
** Regional Fisheries Office, 1988

Potential annual yield: 1 000 t/yr (FAO, 1984)

LAKE KITERE

Geographical data
Location: Tanzania - 10° 22'S; 39° 45'E
Surface area: 7.9 km^2
Max. length: 4.5 km
Max. width: 2.5 km
Inflowing river: Mambi
Outflowing river: Mambi

LAKE LWELO

Location: Tanzania (Kagera Lakes Complex)

LAKE MAGADI

Geographical data
Location: Tanzania - 3° 11'S; 35° 32'E
Surface area: 8.4 km^2
Max. length: 4 km
Max. width: 3 km
Special features: soda lake situated in Ngorongoro Crater

LAKE MAGADI

Geographical data
Location: Tanzania - 3° 5'S; 36° 10'E
Surface area: 6 km^2
Max. length: 3.5 km
Max. width: 2.5 km
Inflowing river: Emugur Opetati
Outflowing river: none - internal basin

LAKE MAMKA

Geographical data
Location: Tanzania - 4° 44'S; 38° 5'E
Surface area: 2.5 km^2
Max. length: 3 km
Max. width: 1.5 km

LAKE MANSI

Geographical data
Location: Tanzania - 7° 17'S; 39° 5'E
Surface area: 39 km^2
Max. length: 14 km
Max. width: 4 km
Outflowing river: Mbezi
Special features: largely overgrown with vegetation

LAKE MANYARA

Geographic location (Welcomme, 1972)
Location: Tanzania - 3° 25'-3° 45'S; 35° 50'E
Altitude: 1 045 m
Surface area: Approx. 470 km^2
Max. length: 40 km
Max. width: 15 km
Depth: 3.7 m (max) (Melack & Kilham, 1974)
Special features: soda lake; fishing restricted to littoral areas with inflowing rivers

Physical and chemical data
Conductivity: K_{20} 94 000 μS/cm (Talling & Talling, 1965)
K_{20} 8 610 μS/cm (Melack & Kilham, 1974)
pH: 9.1 (Melack & Kilham, 1974)
Ionic composition: (Talling & Talling, 1965)

	mg/l
Na	21 500
K	94
Ca	10
Mg	30
Cl	8 670
SO_4	1 056
SiO_2	19
Total P	65
HCO_3+CO_3	806 meq/l

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1970	-	294	202
1971	640	356	139
1972	729	296	197
1973	164	101	54
1974	172	252	72

LAKE MINYERE

Geographical data
Location: Tanzania - 5° 7'S; 35° 4'E
Surface area: 2.5 km^2
Max. length: 3.5 km
Max. width: 1 km
Inflowing river: Mponde
Outflowing river: Mponde

LAKE MKOE

Geographical data
Location: Tanzania - 9° 34'S; 39° 36'E
Surface area: 3.5 km^2
Max. length: 3.3 km
Max. width: 1.5 km
Inflowing river: lateral spillage from Mbwemkuru
Outflowing river: channel to Mbwemkuru

LAKE MUJUNJU (= RWAKAJUNJU)

Geographic location (Kiss, 1977a)
Location: Tanzania - 1° 40'S; 30° 55'E (Kagera Lakes Complex)
Altitude: 1 280 m
Surface area: 80 km^2
Depth: 11 m (max); 5.9 m (mean)
Volume: 182 x 10^6 m^3
Shoreline: 57 km
Max. length: 14.9 km
Max. width: 6.1 km

Physical and chemical data (Kiss, 1977a)
Conductivity: K_{25} 97 µS/cm (surface); 98 µS/cm (bottom)
pH: 8.5 (surface); 7.4 (bottom)
Surface temperature: 23-25° C
Ionic composition:

	mg/l
Na	6.5
K	4.6
Ca	5.35
Mg	4.34
HCO_3+CO_3	45.75 (surface); 48.80 (bottom)
Cl	9.23 (surface); 10.29 (bottom)
Fe++	0.15 (surface); 0.80 (bottom)

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1969-70	472	-	-
1971-74	-	-	-
1975	370	100	86 (Blin, 1977)

LAKE NATRON
(International water)

Geographical data (Welcomme, 1972)
Location: Kenya, Tanzania - 2° 10'- 2° 35'S; 36° E
Altitude: 675 m
Surface area: 1 000 km^2
Max. length: 50 km
Max. width: 25 km
Special features: highly alkaline

LAKE NATRON (cont.)

Physical and chemical data (Guest & Stevens, 1951)
Ionic composition:

	mg/l
K	3 000
Cl	65 000
SO_4	3 100
SiO_2	850
HCO_3+CO_3	2 600 meq/l
PO_4-P	29 000 µg/l

LAKE NDUTU

Geographical data
Location: Tanzania - 2° 59'S; 35° 2'E
Surface area: 13.5 km^2 (varies seasonally)
Max. length: 5.5 km
Max. width: 3.5 km

LAKE NYASA/MALAWI
(International water)

Geographic location (Welcomme, 1972)
Location: Malawi, Mozambique, Tanzania
9° 30'-14° 40'S; 34° -35° E
Altitude: 471 m
Surface area: 30 800 km^2 total (see Fig. 4)
24 400 km^2 in Malawi; 6 400 km^2 in Mozambique;
Tanzania claims 5 569 km^2 of Malawian waters
Max. length: 603 km
Max. width: 87 km
Depth: 758 m (max); 426 m (mean)
Volume: 8 400 km^3
Shoreline: 1 500 km (total lake); 300 km in Tanzania
Catchment area: 65 000 km^2
Annual fluctuation in level: 6 m
Major inflowing rivers: Ruhuhu, Songwe
Outflowing river: Shire
Special features: Tanzania has some 300 km of shoreline on the lake, but because the Nyasa area is remote from major centres of population, development activity has been minimal and the evolution of the fisheries has not been well documented. It is not known to what extent the development of the Nyasa fisheries is complicated by the question of territorial jurisdiction. Around the time of Independence, it was reported that the formal border between Malawi and Tanzania coincided with the Tanzanian shoreline, so that, in theory, all the waters of the lake belonged to Malawi (Dibbs, 1964).

Physical and chemical data (Jackson *et al.*, 1963)
Conductivity: K_{20} 220 µS/cm
Surface temperature: 23-25° C
pH: 7.7-8.6
Alkalinity: N x 10^{-4}: 20.0-25.9

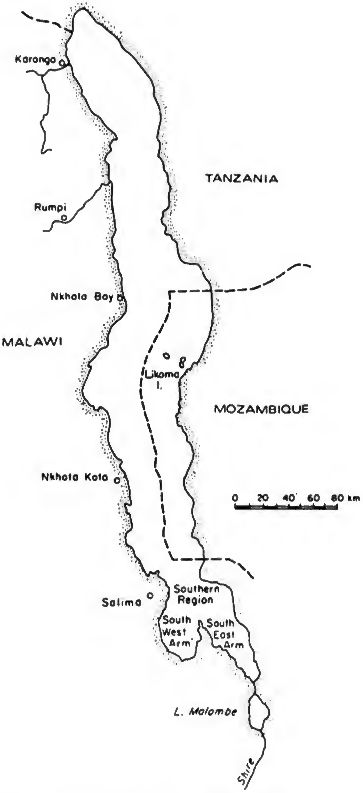


Fig. 4. LAKES NYASA/MALAWI AND MALOMBE
(Welcomme, 1972)

LAKE NYASA/MALAWI (cont.)

Physical and chemical data (cont.)

Ionic composition:

	(Jackson *et al.*, 1963) mg/l	(Talling & Talling, 1965) mg/l
Na	-	21.0
K	-	6.4
Ca	15.1-20.2	19.8
$CaCO_3$	100.0-129.0	-
Mg	6-9	4.7
HCO_3+CO_3	-	144.0
Cl	-	4.3
SO_4	-	<5.0-5.5
SiO_2	1.5-7.0	1.1
NO_3-N	0.02	-
PO_4-P	0.1-0.2	-

Fisheries data

No. of fish species:

245 described species, of which 193 are cichlids (Greenwood, 1964)

No. of fishermen: (Welcomme, 1972)

Malawi	6 500
Tanzania	3 654

No. of boats: (Welcomme, 1972)

Malawi	1 000 canoes 100 dinghies 25 boats
Tanzania	1 898 canoes

Total annual catch and effort: (from Tanzanian shore)

Year	Total catch (t)	No.of fishermen	No.of boats
1973	-	2 807	1 991
1974	6 693	2 781	2 284
1975	6 303	-	-
1976	1 264	-	-
1977	9 794	-	-
1978	872	-	-
1979	743	-	-
1980	946	-	-
1981	7 496	-	-
1986	24 800-35 900* 10 000-15 000**		

* Official estimate, Fisheries Department, 1988.

** Current estimate, several authors cited in Reynolds, 1989

Campbell and Moreni (1988) noted that fishing activity along the Tanzanian shore appeared to be minimal, owing to lack of gear and inadequate craft.

Potential annual yield: (cited in Balarin, 1985b)

15 000 t/yr (Robinson, 1982)
100 000 t/yr (MNRT, 1983)

LAKE NZIWI

Geographical data
Location: Tanzania
Surface area: 6.1 km^2

LAKE RUKWA

Geographical data (Welcomme, 1972)
Location: Tanzania - 7° 38'-8° 22'S; 31° 49'-32° 55'E
Altitude: 500 m
Surface area: 2 300 km^2 circa (total area)
The lake is divided into a permanent South Lake with a shallow North Lake which dries up from time to time.
Depth: 6.5 m (max)
Max. length: 150 km
Max. width: 15 km

Physical and chemical data
Conductivity: North Lake: K_{20} 5 120 μS/cm (Talling & Talling, 1965)
South Lake: K_{25} 354-400 μS/cm
pH: 8.0-9.3
Ionic composition:

	South Lake (Ricardo, 1939) mg/l	North Lake (Talling & Talling, 1965) mg/l
Na	149.4	1 140.0
K	19.4	85.0
Ca	12.2	<1.0
Mg	4.6	<1.0
Cl	25.8	383.0
SO_4	2.9	130.0
SiO_2	76.7	115.0
HCO_3+CO_3	7.09 meq/l	53.5 meq/l
Total P	-	4 500.0 μg/l

Fisheries data
No. of fish species: 17 (Poll, 1957)
No. of fishermen: 1 381 in 1970 (Welcomme, 1972)
No. of boats: 1 376 in 1970 (Welcomme, 1972)
Total annual catch and effort:

Year	Total catch (t)	No. of fishermen	No. of boats
1970	9 879	1 381	1 376
1971	6 613	1 458	1 466
1972	-	-	-
1973	4 817	1 583	1 371
1974	2 287	882	725
1975	3 342	546	-
1976	2 462	3 050	1 988
1977	3 007	349	282
1978	5 905	515	479
1979	175	-	-
1980	118	-	-
1981	313	-	-
1986	5 990	(Regional Fisheries Office, 1988)	

Potential annual yield: 3 000 t (FAO, 1984)

LAKE RUTAMBA

Geographical data
Location: Tanzania - 10° 2'S; 39° 28'E
Surface area: 2.4 km^2
Depth: 6-8 m (max); 2 m (mean)
Max. length: 3.5 km
Max. width: 2.3 km
Annual fluctuation in level: 2 m
Inflowing river: Nghara
Outflowing river: Lupululu

Fisheries data
No. of fishermen: 115 (1979)
No. of boats: 28 (1979)
Total annual catch:
79 t in 1979
32 t in 1987 (Regional Fisheries Office, 1988)

LAKE SAGARA

Geographical data
Location: Tanzania - 5° 13'S; 31° 6'E
Surface area: 9.6 km^2
Max. length: 5.5 km
Max. width: 2.5 km
Inflowing river: Zivwe
Outflowing river: Zivwe

LAKE SEKENA

Location: Tanzania (Kagera Lakes Complex)

LAKE SINGIDA

Geographical data
Location: Tanzania - 4° 47'S; 35° 45'E
Surface area: 12.3 km^2
Max. length: 7 km
Max. width: 2.5 km

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1967	50	23	10
1968	249	46	23
1969	246	56	28
1970	259	50	17
1971	416	38	18
1972	113	38	18

LAKE TANGANYIKA
(International water)

Geographical data (Welcomme, 1972)

Location: Burundi, Tanzania, Zaire, Zambia
3° 23'-8° 50'S; 30° E (see Fig. 5)
Altitude: 773 m
Surface area:

Burundi	2 600 km^2	(8%)
Tanzania	13 500 km^2	(41%)
Zaire	14 800 km^2	(45%)
Zambia	2 000 km^2	(6%)
Total	32 900 km^2	

Depth: 1 435 m (max); 700 m (mean)
Volume: 18 940 km^3
Max. length: 673 km
Max. width: 48 km
Shoreline: 1 500 km (540 km in Tanzania)
Catchment area: 249 000 km^2
Major inflowing rivers: Malagarasi, Ruzizi
Outflowing river: Lukuga

Physical and chemical data (Talling & Talling, 1965)

Conductivity: K_{20} 520-610 μS/cm
pH: 7.3-7.8
Ionic composition:

	mg/l
Na	57.0
K	35.0
Ca	9.8
Mg	43.3
Cl	26.5
SO_4	5.0
SiO_2	0.38
HCO_3+CO_3	6.71 meq/l

Fisheries data

No. of fish species: 214, of which 134 belong to the family Cichlidae (Greenwood, 1964)
Total annual catch and effort:

In Lake (FAO, 1988)

Burundi	16 000 t
Tanzania	25 000 t
Zaire	30 000 t
Zambia	14 000 t
Total	85 000 t

In Tanzania

Year	Total catch (t)	No.of fishermen	No.of boats
1950	3 670	-	-
1951-63	-	-	-
1964	16 163	-	-
1965	15 825	-	-
1966	15 000	-	-
1967	22 497	5 360	3 259
1968	-	8 633	3 505
1969	14 184	6 933	3 712
1970	46 452	6 102	3 405

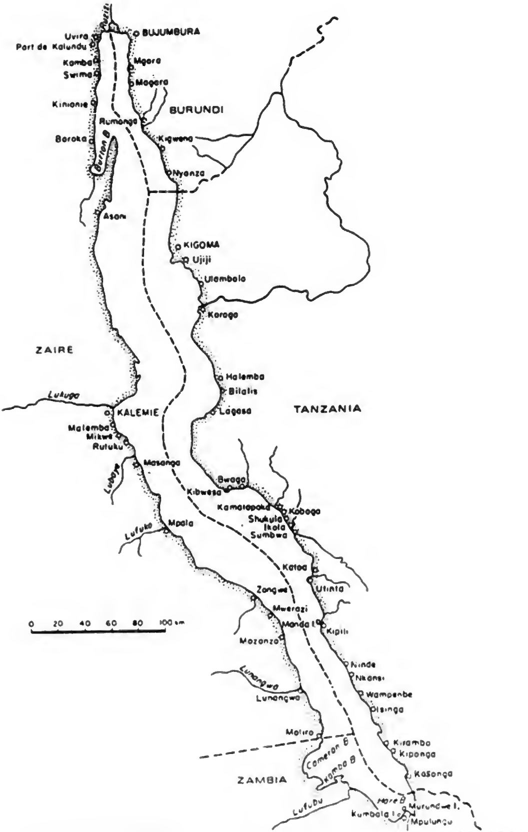


Fig. 5. LAKE TANGANYIKA
(Welcomme, 1972)

LAKE TANGANYIKA (cont.)

Fisheries data (cont.)

Year	Total catch (t)	No.of fishermen	No.of boats
1971	50 568	7 877	3 958
1972	49 017	11 781	4 950
1973	55 922	13 448	7 017
1974	76 619	13 150	6 840
1975	64 345	14 447	-
1976	73 556	14 238	8 408
1977	61 888	15 426	7 654
1978	36 456	8 978	-
1979	44 174	13 342	10 432
1983-86	100 000-115 000 *		
1983-86	25 000 **		

* (Official estimate, Fisheries Dept., 1988)
** (FAO, 1988a)

Note: Catch statistics for the extensive Lake Tanganyika fishery (Tanzania sector) must be treated with caution. A complicating factor is brought on by the dynamics of the principal fish stocks. A cyclical interaction between the small pelagic *Stolothrissa* and *Limnothrissa* species ("dagaa") and the predator *Lates* species results in dramatic fluctuations in exploitable stocks over intervals of time. Production levels fluctuate accordingly (Reynolds, 1989).

Potential annual yield:

Burundi	21 000 t	
Tanzania	122 000 t	
Zaire	138 000 t	
Zambia	19 000 t	
Total	300 000 t	(90 kg/ha/yr - Welcomme, 1972)
Tanzania	100 000 t	(FAO, 1984)
	200 000-300 000 t	(MNRT, 1983)

LAKE TLAWI

Geographical data

Location:	Tanzania - 3° 54'S; 35° 27'E
Surface area:	3.2 km^2
Max. length:	3 km
Max. width:	1.5 km

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No. of fishermen	No. of boats
1972	8.0	2.0	2.0
1973	4.3	7.0	2.0
1974	16.0	7.0	6.0
1975	9.4	6.0	6.0
1976-77	-	-	-
1978	1.4	4.0	5.0
1979	0.7	35.0	17.0

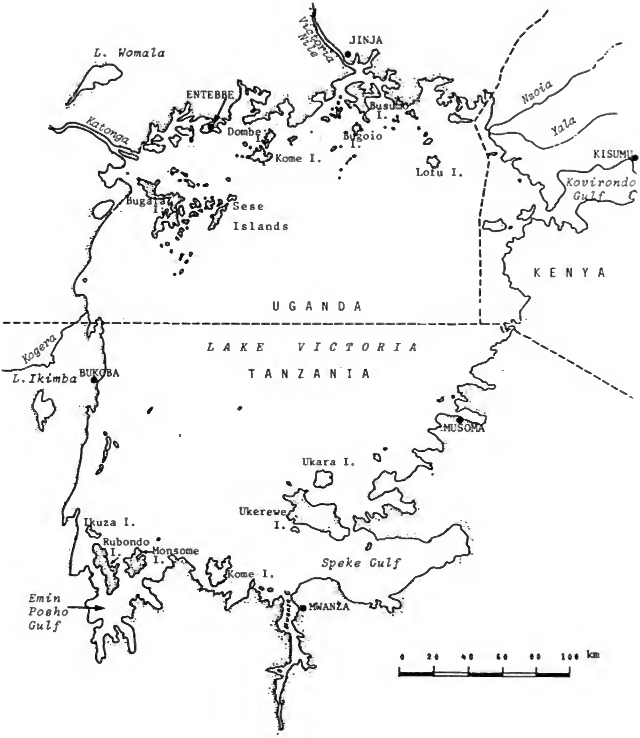


Fig. 6. LAKE VICTORIA
(Welcomme, 1972)

LAKE VICTORIA
(International water)

Geographical data (Welcomme, 1972)
Location: Kenya, Tanzania, Uganda (see Fig. 6)
0° 20'N-3° 0'S; 31° 39'-34° 53'E
Altitude: 1 136 m
Surface area:

Kenya	4 100 km^2	(6%)
Tanzania	33 700 km^2	(49%)
Uganda	31 000 km^2	(45%)
Total	68 800 km^2	

Depth: 84 m (max); 40 m (mean)
Max. length: 400 km
Max. width: 240 km
Shoreline: 3 440 km
Catchment area: 263 000 km^2
Major inflowing rivers: Kagera, Nzoia, Yala
Outflowing river: Victoria Nile

Physical and chemical data
Conductivity: K_{20} 91 μS/cm (EAFRO, 1952b)
98 μS/cm (EAFRO, 1954)
pH:
Kavirondo Gulf: 8.2 (Talling & Talling, 1965)
9.0 (Graham, 1929)
Open lake: 8.0 (Talling & Talling, 1965)
8.5 (Graham, 1929)
Dissolved solids: 97 mg/l
Ionic composition:

	(EAFRO, 1952a) mg/l	(Talling & Talling, 1965) mg/l
Na	12.5-13.5	10.4
K	3.7-4.2	3.8
Ca	5.0-7.0	5.6
Mg	2.3-3.5	2.6
Cl		3.9
SO_4	0.8	
SiO_2	3-9	4.2
$HCO_3 + CO_3$	1.0-1.1 meq/l	0.9 meq/l
NO_2-N		11 μg/l
PO_4-P		13 μg/l
Total P		47 μg/l

Fisheries data
No. of fish species: 177, of which 127 are cichlids (Greenwood, 1964) (mostly *Haplochromis* spp.)

Introduced:
-in the 1950's:
Oreochromis niloticus, *O. leucostictus*, *Tilapia zillii*, *rendalli*
-in late 1950's, beginning 1960's:
Lates niloticus

In the 1960's and 1970's, *Haplochromis* species constituted an estimated 80% of the lake's fish biomass (FAO, 1973).

In the late 1970's and in the 1980's, the Nile Perch *L. niloticus* population increased extremely, to the detriment mainly of the *Haplochromis* population. (see Tables 4, 5, underlined). It is anticipated that the Nile Perch population will begin to decrease as the *Haplochromis* stocks become seriously depleted (TDRI, 1983).

LAKE VICTORIA (cont.)

Fisheries data (cont.)
Total annual catch and effort:
In Lake: see Table 4
In Tanzania:

Year	Total catch (t)	No.of fishermen	No.of boats
Miscellaneous sources:			
1958	26 235	-	-
1959	31 302	9 643	1 693
1960	28 816	-	-
1961	15 937	-	-
1962	18 814	-	-
1963	42 542	-	-
1964	41 839	-	-
1965	43 779	6 077	1 289
1966	34 029	-	-
1967	43 752	-	-
1968	59 353	11 517	2 538
1969	53 927	9 738	2 495
1970	48 292	12 091	3 785
1971	42 552	14 131	3 302
1972	40 926	14 690	3 494
1973	49 615	15 917	3 976
1974	41 526	13 381	3 332
1975	46 602	15 037	-
1976	48 250	15 769	3 794
1977	65 415	14 327	3 398
1978	46 553	17 654	3 448
1979	55 127	20 937	4 457

Definite sources:
1975, 1979, 1985: see Table 5
1986/87: circa 150 000 *

* (after several authors, cited in Reynolds, 1989)

Potential annual yield: 100 000 t in Tanzania (CIFA, 1981)
63 000 t in Tanzania (FAO, 1984)

LAKE VICTORIA (cont.)

Table 4. TOTAL FISH PRODUCTION - LAKE VICTORIA, 1975, 1979, 1985
(after Reynolds & Greboval, 1988)

Species	1975	(%)	1979	(%)	1985*	(%)
	(t)		(t)		(t)	
O. esculentus	3 690	4.8	94	2.2		
O. niloticus	6 092	7.9	3 320	3.2	20 093	10.7
Other tilapia	3 509	4.6	6 355	6.0		
Bagrus	10 146	13.2	13 482	12.8	9 276	4.9
Lates	301	0.4	4 476	4.3	87 637	46.7
Protopterus	7 844	10.2	6 445	6.1	4 200	2.2
Haplochromis	22 458	29.2	29 909	28.4	11 578	6.2
Clarias	6 382	8.3	7 917	7.5	6 107	3.3
Barbus	775	1.0	1 141	1.1	515	0.3
Synodontis	2 491	3.2	7 356	7.0	9 278	4.9
Mormyrus	178	0.2	897	0.9	402	0.2
Labeo	1 719	2.2	7 332	7.0	544	0.3
Schilbe	1 069	1.4	1 958	1.9	1 582	0.8
Rastrineobola**	4 558	5.9	10 989	10.4	25 866	13.8
Other small mixed	4 707	7.4	1 419	1.3	10 417	5.6
TOTAL	76 919		105 267		187 495	

Sources: CIFA, 1981; DFK Statistical Bulletins; Bwathondi, 1988.
* Figures for 1985 combine Kenya and Tanzania only
** Tanzania combines "Rastrineobola" and "Other Small Mixed."

Table 5. TANZANIA FISH PRODUCTION - LAKE VICTORIA, 1975, 1979, 1985
(after Reynolds & Greboval, 1988)

Species	1975	1979	1985
	(t)	(t)	(t)
O. esculentus	3 592	1 997	
O. niloticus	0	1 608	10 651
Other tilapia	2 057	3 952	
Bagrus	5 827	5 183	9 215
Lates	0	0	37 608
Protopterus	6 180	4 603	4 050
Haplochromis	16 148	21 760	11 572
Clarias	2 508	2 558	5 560
Barbus	232	364	402
Synodontis	2 295	4 334	9 278
Mormyrus	80	408	353
Labeo	1 601	6 849	544
Schilbe	1 015	1 638	1 577
Rastrineobola/ Other small mixed	5 058	2 661	8 096
Total	46 593	57 915	98 906

Sources: CIFA, 1981; DFK Statistical Bulletins; Bwathondi, 1988.

LAKE WELU

Geographical data
Location: Tanzania
Surface area: 3.2 km^2

BUBU RIVER

Geographical data
Source: Mt. Hanang, Tanzania
Altitude: 3 417 m
Total length: 225 km
Countries traversed: Tanzania
Major tributaries: Umo
Discharges to: Bahi Swamp

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1969	19	30	15
1970	49	232	6
1971	11	220	4
1972	35	97	25
1973	19	93	25
1974	22	42	23
1975	-	-	-
1976	40	158	13
1977	70	12	11
1978	126	115	5
1979	71	86	-

GREAT RUAHA RIVER

Geographical data
Source: Poroto Mountains and Kipengere Range
Altitude: 2 961 m
Total length: circa 750 km
Drainage area: 84 000 km^2
Countries traversed: Tanzania
Major tributaries: Njombe, Little Ruaha
Discharges to: Rufiji River
Volume of discharge at mouth: 103 m^3/sec (mean)
Flood regime: peak floods in March (high water from January to May)
Special features: Usanga floodplain (3 300 km^2); Kidatu and Mtera reservoirs; Ngwazi Reservoir on Little Ruaha.

Physical and chemical data (Petr, 1974)

	Upper mg/l	Middle mg/l	Lower mg/l
Conductivity K_{20} µS/cm	32.0	130.0	177.0-186.0
Surface temp. °C	17.8-21.8	26.6	24.2-27.7
pH:	6.3	7.3-7.8	6.8-7.4
Hardness $CaCo_3$	0	25.0	0
Fe+	-	0.2	0-0.2
Mn	-	0	0-0.2
SiO_2	14.0	20.0	20.0-26.0
Na	-	11.4	12.0
SO_4	2.0	2.0-27.0	31.0-34.0

GREAT KUAHA RIVER (cont.)

Fisheries data
Total annual catch and effort: (Mtere area)

Year	Total catch (t)	No.of fishermen	No.of boat
1971	41	-	-
1972	38	30	38
1973	93	48	41
1974	115	56	54
1975	-	-	-
1976	26	19	19
1977	17	11	11
1978	40	26	26
1987	392*		

* including Ruaha-Usanga Basin (Regional Fisheries Office, 1988)

KAGERA RIVER
(International water)

Geographical data
Source: Burundi, Rwanda
Total length: 785 km
Countries traversed: Burundi, Rwanda, Tanzania, Uganda
Major tributaries: Akanyaru, Nyabarongo, Ruvubu
Discharges to: Lake Victoria
Special features:

(1) Upper Kagera Lakes Complex: a group of lakes distributed as follows:
in Burundi: Ingitamo, Kacamurinda, Kanzigiri, Lirwihinda, Rungazi;
in Rwanda: Birira, Gaharwa, Gashanga, Kidogo, Kirimbi, Mirayi, Mugesera, Muhazi, Murago, Sake;
international waters (Burundi/Rwanda): Cyohoha South, Rugwero.

(2) Rusumo Falls: in Rwanda.

(3) Lower Kagera Lakes Complex and Floodplain/Swamp: a group of lakes and adjacent floodplain/swamp. Lakes distributed as follows:
in Rwanda: Chuju, Hago, Ihema, Iwapibali, Kishwanja, Kivumba, Mihindi, Muhari, Nasho, Ngerenke, Rukira, Rwakibare, Rwampanga, Rwanyakizinga, Rwehihama, Sekena;
in Tanzania: Bisongo, Kajumbura, Lwelo, Mujunju, Rushwa.
Floodplain/Swamp area in Rwanda: circa 1 000 km^2.

Note: also called "Akagera".

Physical and chemical data (Kiss, 1977a)
Conductivity: K_{25} 111 μS/cm
pH: 7.01
Ionic composition:

	mg/l
Na	4.1
K	1.0
Ca	4.6
Mg	4.9
Cl	7.4
HCO_3+CO_3	42.7
Fe++	0.3

KILOMBERO RIVER/FLOODPLAIN

Geographical data
Source: near Njombe (Ruhudji tributary)
Altitude: 1 951 m
Total length: circa 445 km
Drainage area: 40 000 km^2
Countries traversed: Tanzania
Major tributaries: Ruhudji, Mnyera, Mpanga, Pitu
Discharges to: Rufiji at confluence with Lugenda
Volume of discharge at mouth: 482.8 m^3/sec (mean)
Special features: Kilombero floodplain (4 000 km^2), the largest in Tanzania

Fisheries data
Total annual catch and effort: (Kilombero River & Floodplain)

Year	Total catch (t)	No.of fishermen	No.of boats
1971	1 000	-	-
1972-75	-	-	-
1976	8 549	337	332
1977	7 048	350	290
1978	2 042	332	250
1979	2 412	196	114
1980	14 700	11 260	2 100
1987	829*		

* (Regional Fisheries Office, 1988)

MALAGARASI RIVER/SWAMP
(International water)

Geographical data
Source: along Tanzania/Burundi frontier
Altitude: 1 859 m
Total length: 470 km (110 km along Tanzania/Burundi frontier); Ugalla tributary is 495 km
Drainage area: 131 572 km^2 (126 133 km^2 in Tanzania; 5 439 km^2 in Burundi)
Countries traversed: Tanzania, Burundi
Major tributaries: Ugalla, Luanga
Discharges to: Lake Tanganyika - 5° 13'S; 29° 49'E
Special features: Malagarasi Swamp (1 800 km^2 - second largest swamp in Tanzania); Ugalla Swamp, Lake Sagara

Fisheries data
Total annual catch and effort: (in Tanzania)

Year	Total catch (t)	No.of fishermen	No.of boats
Malagarasi River and Swamp			
1966	1 500	-	-
1967	-	736	-
1968	472	478	-
1987 (avg)	238*		

MALAGARASI RIVER/SWAMP (cont.)

Fisheries data (cont.)
Total annual catch and effort: (in Tanzania)

Year	Total catch (t)	No.of fishermen	No.of boats
Ugalla River and Swamp			
1967	-	135	-
1968-70	-	-	-
1971	1 037	867	356
1987 (avg)	200*		

* Regional Fisheries Office, 1988

PAGANI RIVER

Geographical data
Source: Kilimanjaro and Meru Mountains
Altitude: 5 895 m (Kilimanjaro)
Total length: 395 km
Drainage area: 29 526 km^2
Countries traversed: Tanzania
Major tributaries: Ruvu, Kilkuletwa
Discharges to: Indian Ocean - 5° 25'S; 39° 0'E
Volume of discharge at mouth: 0.846 km^3/annum
Flood regime: peak discharges in November and April
Special features: Nyumba ya Munga Reservoir, Lake Jipe on Ruvu tributary; Lakes Kalimawe and Mamba on smaller tributaries.

RUFIJI RIVER/FLOODPLAIN

Geographical data
Source: confluence of Kilombero and Luwegu tributaries
Total length: 300 km (Kilombero/Luwegu confluence to Indian Ocean)
Drainage area: 177 000 km^2
Countries traversed: Tanzania
Major tributaries: Kilombero, Great Ruaha, Luwegu
Discharges to: Indian Ocean - 7° 45'S; 39° 22'E
Volume of discharge at mouth: 1 133 m^3/sec (mean); 26.225 km^3/yr
Special features: Floodplain (1 450 km^2) along lower reach

Fisheries data
No. of fishermen: circa 3 200 (date unknown)
Total annual catch: 2 700 t (1971) (Bernacsek, 1980); no recent sources located

RUVU RIVER

Geographical data
Source: Uluguru Mountains
Altitude: 2 646 m
Total length: 270 km
Drainage area: 18 389 km^2
Countries traversed: Tanzania
Major tributaries: Ngerengere, Mgeta
Discharges to: Indian Ocean - 6° 23'S; 38° 52'E
Volume of discharge at mouth: 1.988 km^3/annum

RUVUBU RIVER
(International water)

Geographical data
Source: Burundi
Length: 130 km in Burundi
Countries traversed: Burundi, Tanzania
Discharges to: Kagera River

RUVUMA RIVER/FLOODPLAIN
(International water)

Geographical data
Source: near Songea, Tanzania
Altitude: 1 558 m
Total length: 640 km
Drainage area: 165 760 km^2
(113 701 km^2 in Mozambique; 52 059 km^2 in Tanzania)
Countries traversed: Mozambique, Tanzania
Major tributaries: Lugenda in Mozambique (555 km-long channel)
Discharges to: Indian Ocean - 10° 28'S; 40° 25'E
Special features: Lakes Chiuta and Amaramba on Lugenda tributary; floodplain and several associated lakes on lower course (i.e., Lake Chidya in Tanzania and Lake Nangade in Mozambique)

Fisheries data
Total annual yield: 2 000 t possible (Bernacsek, 1980); no recent sources located

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SONGWE RIVER
(International water)

Geographical data
Source: near Vwawa, Tanzania
Altitude: 1 877 m
Total length: 165 km
(25 km in Tanzania only; 140 km along Tanzania/Malawi frontier)
Countries traversed: Tanzania, Malawi
Discharges to: Lake Malawi/Nyasa - 9° 43'S; 33° 57'E

WAMI RIVER

Geographical data
Source: near Chandama, Tanzania
Altitude: 1 859 m
Total length: 490 km
Drainage area: 46 361 km^2
Countries traversed: Tanzania
Major tributaries: Mkata, Gombo Mkondoa
Discharges to: Indian Ocean - 6° 10'S; 38° 51'E
Volume of discharge at mouth: 1 993 km^3/annum
Special features: Hombolo Reservoir, Kilosa Swamps, Lake Gombo

Fisheries data
Total annual catch and effort: (excluding reservoir, swamp and lakes)

Year	Total catch (t)	No.of fishermen	No.of boats
1972	24	25	13
1973	85	17	17
1974	100	17	17
1975	-	-	-
1976	176	41	16
1977	29	38	15
1978	28	30	12
1979	57	20	18

BAHI SWAMP

Geographical data
Location: Tanzania - 6° 5'S; 35° 10'E
Surface area: 855 km^2 (but extremely variable due to high annual variation in affluent flow)
Major inflowing rivers: Bubu, Maduma, Mponde
Outflowing river: none - internal basin

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1967	dry	-	-
1968	-	-	-
1969	1 140	151	13
1970	223	404	151
1971	257	293	122
1972	370	238	151
1973	1 586	726	282
1974	146	100	60
1975	-	-	-
1976	551	112	56
1977	510	146	-
1978	1 497	200	-
1979	266	200	28
1986	654*		

* including Hombolo and Kisaki Reservoirs
(Regional Fisheries Office, 1988)

KILOSA SWAMP

Geographical data
Location: Tanzania - 6° 50'S; 37° 15'E
Major inflowing rivers: Gombo Mkondoa, Mkata
Outflowing river: Wami

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1972	149	22	10
1973	202	105	60
1974	90	56	60

BUIGIRI RESERVOIR

Geographical data
Location: Tanzania - 6° 8'S; 36° 1'E

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1973	5.3	4	2
1974	-	6	-
1975-76	-	-	-
1977	7.5	2	1

CHAMWALE RESERVOIR

Geographical data:
Location: Tanzania
Surface area: 0.20 km^2

Fisheries data
Total annual catch: 3 t in 1963

CHIBUMAGWE RESERVOIR

Geographical data:
Location: Tanzania

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1967	36	14	5
1968-76	-	-	-
1977	7	22	4
1978	34	20	6

DABALO RESERVOIR

Geographical data

Location: Tanzania

Fisheries data

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1967	2.1	2	2
1968-71	-	-	-
1972	8.0	10	6
1973	3.2	16	6
1974	9.1	9	3
1975	-	-	-
1976	1.5	7	2
1977	2.2	5	1
1978	5.4	3	2
1979	7.0	3	2

ELUANATA RESERVOIR

Geographical data

Location: Tanzania

Surface area: 5.87 km^2

Depth: 2.1 m (max); 0.5 m (mean)

Volume: 2.94×10^6 m^3

ELYSIA RESERVOIR

Geographical data

Location: Tanzania

Physical and chemical data

Conductivity: 110 μS/cm

pH: 6.95

Ionic composition:

	mg/l
Na	14.1
K	1.1
Ca + Mg	25.7
Cl	139.0
SO_4	4.1
HCO_3	59.8
P	0.02
NO_3	18.6

GEITA RESERVOIR

Geographical data

Location: Tanzania - 2° 53'S; 32° 11'E

Surface area: 0.02 km^2

HOMBOLO RESERVOIR

Geographical data

Location:	Tanzania - 5° 57'S; 35° 57'E
Altitude:	100 m at USL
Date closed:	1957
Surface area:	15.4 km^2 at USL
Depth:	12 m (max) at USL
Major inflowing river:	Chadulu
Outflowing river:	Chadulu

Physical and chemical data

Temperature:	22.3-25.8° C
Conductivity:	1 650-2 400 μS/cm at 20° C
pH:	7.2-8.1
Total dissolved solids:	1.2 g/l

Ionic composition:

	mg/l
Na	445.0
K	20.0
SO_4	160.0-250.0
HCO_3	198.0
P	0.01-0.08

Fisheries data

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1963	160	80	-
1964-66	-	-	-
1067	71	25	30
1968	203	-	-
1969	659	48	35
1970	415	67	46
1971	305	50	46
1972	170	48	48
1973	180	44	40
1974	239	41	32
1975	-	-	-
1976	131	39	27
1977	177	37	31
1978	113	36	24
1979	114	36	18
1986	654*		

* including Bahi Swamp and Kisaki Reservoir (Regional Fisheries Office, 1988)

IGOMBE RESERVOIR

Geographical data

Location:	Tanzania
Surface area:	12.95 km^2
Volume:	39.7×10^6 m^3

IGOMBE RESERVOIR (cont.)

Fisheries data

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1963	-	40	-
1964-70	-	-	-
1971	-	76	35

IGUNDU RESERVOIR

Geographical data

Location: Tanzania

Fisheries data

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1977	3.3	22	10
1978	4.5	22	20

IKOWA RESERVOIR

Geographical data

Location: Tanzania

Fisheries data

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1969	4.6	3	3
1970	-	8	3
1971	-	9	2
1972-75	-	-	-
1976	4.6	2	2
1977	16	4	2
1978	12	5	2
1979	6.8	4	2

KALIMAWE RESERVOIR

Geographical data

Location: Tanzania

Surface area: 8.1 km^2

Depth: 1.85 m (mean)

Volume: 15×10^6 m^3

KALIMAWE RESERVOIR (cont.)

Fisheries data

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1963	-	120	30
1964-66	-	-	-
1967	-	250	150

KERENGE RESERVOIR

Geographical data

Location: Tanzania

Surface area: 0.83 km^2

Physical and chemical data

Conductivity: 319 μS/cm

pH: 8.10

Ionic composition:

	mg/l
Na	20.0
K	4.2
Ca	42.7
Mg	50.6
Cl	31.9-36.0
SO_4	7.6
HCO_3	73.4-123.0
P	0.62
NO_3	55.8

Fisheries data

Total annual catch: (No. of fishermen and boats not available)

Year	Total catch (t)	
1954	6.5	(6 months)
1955	6.4	(10 months)
1956	12.1	
1957	10.3	
1958	4.9	
1959	-	
1960	9.9	
1961	16.1	
1962	7.3	
1963	10.9	

KIDATU RESERVOIR

Geographical data

Location: Tanzania - 7° 39'S; 36° 55'E

Altitude: 450 m at USL

Dam height: 40 m

Date closed: November 1975

Surface area: 9.6 km^2 at USL

Depth: 30 m (max); 17.2 m (mean) at USL

Volume: 0.165 km^3 at USL

KIDATU RESERVOIR (cont.)

Geographical data (cont.)
Max. length: 22.4 km
Max. width: 0.6 km
Annual fluctuation in level: 17 m (theoretical)
Major inflowing river: Great Ruaha
Outflowing river: Great Ruaha

KISAKI RESERVOIR

Geographical data
Location: Tanzania - 7° 28'S; 37° 37'E

Physical and chemical data
pH: 7.50
Ionic composition:

	mg/l
Ca	22.0
Mg	6.0
Cl	20.0
SO_4	nil
HCO_3	195.0

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1967	30	24	9
1968	-	-	-
1969	20	22	11
1970	45	42	15
1971	20	39	11
1972	15	29	11
1973	19	22	13
1974	19	19	14
1975	-	-	-
1976	11	23	11
1977	13	27	15
1978	19	26	13
1979	29	30	10
1986	654*		

* including Bahi Swamp and Hombolo Reservoir
(Regional Fisheries Office, 1988)

MAGINDU RESERVOIR

Geographical data
Location: Tanzania
Surface area: 0.01 km^2

Fisheries data
Total annual catch: 0.2 t in 1963

MALYA RESERVOIR

Geographical data

Location:	Tanzania - 2° 59'S; 33° 33'E
Date closed:	1947
Surface area:	0.70 km^2
Depth:	9.4 m (max)

Physical and chemical data

Temperature:	20.6-22.9° C
pH:	7.6-7.7

Ionic composition:

	mg/l
NO_3	0.14-0.15
P	trace

Fisheries data

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1963	19.5	8	-
1964-76	-	-	-
1977	2.5	3	3
1978	13.0	4	3

MANDA RESERVOIR

Location: Tanzania

MGORI RESERVOIR

Geographical data

Location:	Tanzania - 4° 47'S; 35° 56'E
Surface area:	0.81 km^2

Fisheries data

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1963	-	7	-
1964-66	-	-	-
1967	30	5	5
1968	61	22	11
1969	152	14	7
1970	69	9	5
1971	25	9	4
1972	36	9	4
1973	19	13	5
1974	36	25	6
1975	-	-	-
1976	21	27	6
1977	8.3	14	4
1978	14.6	32	3

MIANJI RESERVOIR

Geographical data
Location: Tanzania
Surface area: 4.9 km^2

Physical and chemical data
Conductivity: 690 - 1 227 μS/cm
pH: 7.76-8.8
Ionic composition:

	mg/l
Na	100.0-130.0
K	6.2
Ca	46.0
Mg	15.0
Cl	184.0-778.0
SO_4	nil-trace
HCO_3	92.1-280.0
P	nil-0.02
NO_3	18.6

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1963	55	-	-
1964-66	-	-	-
1967	41	5	7
1968	47	24	12
1969	97	18	9
1970	27	9	6
1971	44	6	5
1972	27	6	5
1973	68	20	8
1974	20	20	2
1975	-	-	-
1976	5.9	39	6
1977	0.6	11	4
1978	12.6	82	6

MINDUTULIENI RESERVOIR

Geographical data
Location: Tanzania

Physical and chemical data
Conductivity: 858 μS/cm
pH: 7.3
Ionic composition:

	mg/l
Na	95.4
K	6.7
Ca + Mg	114.3
Cl	417.0
SO_4	5.6
HCO_3	82.4
P	0.02
NO_3	12.4

MLOWA RESERVOIR

Geographical data
Location: Tanzania - 7° 41'S; 35° 24'E

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1976	13	4	2
1977	50	5	2
1978	2.7	4	1
1979	6.1	4	1

MTERA RESERVOIR

Geographical data
Location: Tanzania - 7° 7'S; 35° 50'E
Altitude: 698.5 m asl at USL
Dam height: 45 m
Date closed: 24 December 1980
Surface area: 610 km^2 at USL (190 km^2 at low water level)
Depth: 6.23 m at USL
Volume: 3.8 m^3 at USL
Max. length: 56 km
Max. width: 15 km
Annual fluctuation in level: 8.5 m (theoretical)
Major inflowing rivers: Great Ruaha, Kisigo
Outflowing river: Great Ruaha

Fisheries data
Total annual catch: 21 000 t in 1984;
3 254 t in 1986 (Regional Fisheries Office, 1988)

MUCHLUR RESERVOIR

Geographical data
Location: Tanzania
Surface area: 2.9 km^2

MWETEMO RESERVOIR

Geographical data
Location: Tanzania

Physical and chemical data
Conductivity: 272 μS/cm
pH: 7.86

MWETEMO RESERVOIR (cont.)

Physical and chemical data (cont.)

Ionic composition:

	mg/l
Na	5.0
K	22.5
Ca+Mg	75.6
Cl	208.9
HCO_3	104.9
P	0.02
NO_3	24.8
SO_4	nil

MYOMBO RESERVOIR

Geographical data

Location:	Tanzania
Surface area:	0.02 km^2

Fisheries data

Total annual catch: 0.9 t (1963)

NGWAZI RESERVOIR

Geographical data

Location:	Tanzania
Surface area:	5.1 km^2

Fisheries data

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1966	4	-	-
1967-71	-	-	-
1972	13	25	9
1973	16	16	6
1974-75	-	-	-
1976	33	11	11
1977	24	19	9
1978	40	6	6

NHUMBU RESERVOIR

Geographical data

Location:	Tanzania
Surface area:	2.43 km^2

Fisheries data

Total annual catch: 9 t (1957)

NONDWA RESERVOIR

Geographical data
Location: Tanzania

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1963	15	-	-
1964-66	-	-	-
1967	100	15	10
1968	-	-	-
1969	17	17	13
1970	481	51	34
1971	168	25	15
1972	65	18	17
1973	114	25	16
1974	127	18	18
1975	-	-	-
1976	94	14	14
1977	95	19	12
1978	59	12	10
1979	25	20	7

NYUMBA YA MUNGU RESERVOIR

Geographical data

Location:	Tanzania, Kilimanjaro region - 3° 40'S; 37° 25'E
Altitude:	663 m
Date closed:	December 1965
Surface area:	180 km^2 (max); 142 km^2 (mean); 110 km^2 (min)
Depth:	41 m (max); 6 m (mean)
Volume:	1.12 km^3
Max. length:	32 km
Max. width:	15 km
Shoreline:	96 km at USL
Annual fluctuation in level:	circa 3 m
Major inflowing rivers:	Ruvu, Kikuletwa
Outflowing river:	Pangani
Catchment area:	9 143 km^2

Physical and chemical data (Denny *et al.*, 1978; Petr, 1975)

	Dam site	*Ruvu inflow*	*Kikuletwa inflow*
Surface temp. °C	20-28.4	21-28.4	24
Conductivity: K_{25} μS/cm	710-900 (854 mean)	480-550	460-560
pH:	8.6-9.1	6.8-7.7	8.1-8.2
Total alkalinity mg/l - $CaCO_3$:	310-345	170-220	460-560
Total dissolved solids: mg/l	508	285-305	n.d.

NYUMBA YA MUNGU RESERVOIR (cont.)

Physical and chemical data (cont.)

Ionic composition: (mg/l)

	Dam site	*Ruvu inflow*	*Kikuletwa inflow*
Na	119	75	150
K	14.5	4.5	20.0
Ca	18	24-26	36-42
Mg	22.8-24.0	12.0-15.6	37.2
Cl	32.5	15-20	35-45
SO_4	22.5-40.0	12.5-25.0	37.0-60.0
SiO_4	4.5-10.0	5.5-8.5	3.5-10.0
HCO_3+CO_3	402	220.2	-
Fe	<0.05	0.01-0.04	0.01-0.05
NO_2-N	<0.005	<0.005	<0.005
NO_3-N	0.01-0.04	0.08-0.5	0.03-0.04
PO_4-P	0.1-0.5	0.28-0.35	0.35-0.70

Fisheries data

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1967	-	600	-
1968	-	-	-
1969	2 721	-	-
1970	28 509	3 161	1 554
1971	16 688	3 386	1 207
1972	7 287	1 313	906
1973*	2 783	2 419	562
1974*	2 282	1 388	716
1975	4 576	1 471	-
1976	5 421	1 250	593
1977	5 006	1 172	572
1978**	0	-	-
1979	1 500	1 701	626
1980	4 088	1 479	416
1981	3 720	1 253	296
1982	1 867	1 634	376
1983	2 430	1 342	401
1986	4 500	(Regional Fisheries Office, 1988)	
1987	4 300	(Regional Fisheries Office, 1988)	

* By 1973/74 the catches had declined drastically to an estimated level of 3 000 t, due to extraordinarily heavy fishing pressure and declining water levels (Bailey *et al.*, 1978)

** No fishing, due to cholera outbreak

Potential annual yield: 4 500 t (FAO, 1984)

RWAMKONA RESERVOIR

Geographical data

Location:	Tanzania
Surface area:	0.15 km^2

SHISHIYU RESERVOIR

Geographical data
Location: Tanzania

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1977	1.1	4	2
1978	1.2	3	4

UCHAMA RESERVOIR

Geographical data
Location: Tanzania

USIULIZE RESERVOIR

Geographical data
Location: Tanzania

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1977	65	90	4
1978	14	154	45

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UGANDA

1. GEOGRAPHY AND CLIMATE (Welcomme, 1979a)

Uganda (with a surface area of 236 000 km^2) is a high plateau dipping to the southeast to the Lake Victoria Basin. The west of the country is traversed from north to south by the western area of the Great Rift Valley. There is a high mountainous chain, the Ruwezoris, in the extreme west; to the southwest the Bufumbiro volcanoes block the Rift Valley. In the east a chain of volcanic peaks stretches north to south with Mounts Moroto, Kadem and Elgan. The rest of the plateau consists of rolling hills with extensive papyrus swamps in their valleys. There is one major barrage: Owen Falls, across the point where the White Nile leaves Lake Victoria.

Although Uganda lies astride the equator, any climatic severity is eased by its altitude. In the wettest areas along the western shore of Lake Victoria there are two rainy seasons (February-June and April-December). Although the twin season pattern also prevails over the rest of the country, the north and west are much more arid.

Uganda's population is almost entirely rural and scattered, growing staples such as plantains and corn and cash crops such as coffee, cotton and tea.

2. HYDROGRAPHY (mainly adapted from Balarin, 1985c)

In general, Uganda has an abundance of water resources covering an area of nearly 44 000 km^2. This area is made up of over 36 000 km^2 of open water, 5 100 km^2 of swamps, and over 2 000 km of main rivers. Nearly 10 000 permanent springs with a minimum flow of 3.6 m^3/hr has been recorded. The Government of Uganda (1967) also reports the existence of 4 400 boreholes (mean depth 100 m), 963 earth dams (7 m walls) or deep (5 m) ground storages for dry season water holding of 4 500 m^3 for cattle and domestic use, and 3 300 ha of reclaimable swamp suitable for cultivation.

2.1 Lakes

Uganda has an extensive lake system covering over 38 500 km^2. It comprises Lake Victoria and Lake Kyoga, as well as the Rift Valley Lakes (Edward, George and Albert). Lake Kyoga is, in essence, an extension of the Victoria Nile. It is relatively shallow with numerous estuaries and swamps.

2.2 Rivers, Floodplains and Swamps

Uganda lies almost wholly within the White Nile Drainage Basin flowing to the Mediterranean. About 10 regional drainage basins exist, mainly associated with the lakes (see Fig. 1). In the southern part of the country almost all watercourses draining the plateau flow into Lake Victoria and Lake Kyoga. They are characterized by broad shallow valleys, slow moving water and swamp conditions. On the Northern Plateau almost all the watercourses, including River Achwa (or Aswa), are seasonal in flow, due to the dry conditions. The higher mountains of the borders have vigorous parennial streams flowing swiftly down the slopes, in steep river valleys.

The longest river is the Victoria Nile, with a discharge of 1 100-1 700 m^3/sec. By far the largest river is the Albert Nile, which carries almost all of Uganda's runoff.

Over the greater part of western and central Uganda, where upwarping of the Rift Valley has reversed river flows, old drainage courses and their tributaries are now occupied by swamps totalling 5 180 km^2 (Fig. 1).

A distinction is to be made between grassy swamps (57%) and papyrus swamps (43%); the former are mainly seasonal, the latter permanent. About 6% (915 km^2) of the area is considered reclaimable for cultivation. Lake Kyoga, in particular, is characterized by fringe swamps covering over 230 km^2.

2.3 Reservoirs

Other than the Owen Falls hydroelectric dam across the White Nile River near its outflow from Lake Victoria, there are no major impoundments. The Owen Falls dam does not regulate the water level of Lake Victoria to any significant extent although the latter, strictly speaking, acts as a "reservoir" for the hydroelectric plant.

A great number of dams have been constructed throughout Uganda. Government of Uganda (1967) lists 963 ponds, mainly in the Ankole, Teso and Karamoja districts where dry conditions necessitate seasonal water storage. Many have been stocked with fish.

2.4 Coastal Lagoons

There are none; Uganda is landlocked.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

Aquaculture has been applied both to the classical rearing of fish in ponds for subsistence consumption and to the extensive practice of stocking natural water bodies and reservoirs. Both have contributed substantially to fish production in Uganda.

Peak development of aquaculture occurred in 1968 when fish farming was carried out in 11 000 ponds over 410 ha, yielding 800-900 t/yr of fish. TDRI (1983) estimated production at 200 t/yr; however, latest estimates have been more radical: 30 t in 1983; 38 t in 1987 (Vincke, 1989, pers.comm.).

Aquaculture is entirely in the hands of subsistence farmers with small ponds of 100 to 400 m^2.

Table 1. FISH FARMING PRODUCTION IN UGANDA, 1953-1983
(cited by Balarin, 1985c)

Year	Production (t)	Ponds	Total area (ha)
1953		Start up - Construction Kajansi	
1959		5 000	
1960	200-500		
1962	329	7 270 (700 dams)	
1963	200	10 000 (+ 800 dams) (10% well managed)	400
1965	670	11 000 (55% operational)	410
1966	70-113	6 000-8 000 (20-25% neglected)	290
1968	800-900	11 000	410
1974		10 000	
1975	700		
1982	200		
1983	31	11 000 (25% operational)	410

3.2 Fish production and per caput supply

Table 2. FISH PRODUCTION AND PER CAPUT SUPPLY - Uganda, 1970-1987

		Nominal Domestic Production (excluding exports) (t) 2/			Nominal Consumer Supply (exluding imports and exports (kg/person)		
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Total	Inland capture	Aqua-culture 3/	Total
1970	9 806	129 000	- 4/	129 000	13.1	-	13.1
1971	10 065	137 000	-	137 000	13.6	-	13.6
1972	10 331	166 000	-	166 000	16.1	-	16.1
1973	10 604	169 500	-	169 500	16.0	-	16.0
1974	10 884	167 500	-	167 500	15.4	-	15.4
1975	11 171	188 000	700	188 700	16.9	0.06	16.9
1976	11 534	152 400	-	152.400	13.2	-	13.2
1977	11 908	219 220	-	219 220	18.4	-	18.4
1978	12 295	223 830	-	223 830	18.2	-	18.2
1979	12 694	179 930	-	179 930	14.2	-	14.3
1980	13 106	165 840	-	165 840	12.6	-	12.6
1981	13 549	166 590	-	166 590	12.3	-	12.3
1982	14 007	170 035	28 5/	170 063	12.1	0.002	12.1
1983	14 481	172 000 6/	30 5/	172 030	11.9	0.002	11.9
1984	14 971	212 200	31 5/	212 231	14.2	0.002	14.2
1985	15 477	160 800	33 5/	160 833	10.4	0.002	10.4
1986	16 026	197 600	35 5/	197 635	12.3	0.002	12.3
1987	16 595	200 000	38 5/	200 038	12.0	0.002	12.0

1/ Source: FAO

2/ Source: FAO Fisheries Dept. FISHDAB/Govt. of Uganda

3/ included in "Inland capture" if not specified

4/ -: data not available

5/ Vincke, 1989 (pers.comm.)

6/ TDRI 1983 estimate: 78 000 t

3.3 Inland catch range and potential yield

Table 3. INLAND CATCH RANGE AND POTENTIAL YIELD - Uganda

Water body	Period	Annual catch range (t) **	Potential annual yield (t) **
Lakes			
Albert	1983-1986	6 000-3 200	12 000-18 240
Biaina*	1960-1969	2000-984*	-
Bunyoni	-	-	-
Edward	1970-1988	5 730-3 000	4 000
George	1969/70-1976	4 000-4 700	5 000
Kachira	1966	1 100	-
Kayumba	1969	7	-
Kijanebalola	1960-1966	500-800	-
Kwania	-	-	-
Kyahafi	1969	4.5	-
Kyamwiga	-	-	-
Kyoga Complex	1980-1988	131 000-57 000	65 000
Mulehe	1969	27.8	-
Mburo	-	-	-
Mutanda	-	-	-
Nabugabo	-	-	-
Nakivali	1966	274	-
Nyabihoko	1969	150	-
Nyamasungiri	1969	52.7	-
Opeta*	-	-	-
Saka	1969	5	-
Victoria	1983-1986	22 000-56 000	45 000
Wamala	1981-1983	3 800-2 000	4 000.
Rivers			
Kazinga Channel	1976	500	290
Turkwell	-	-	-
White (Albert) Nile	1983-1986	4 000-1 600	6 000
White (Victoria) Nile	-	-	-
Reservoirs			
Kanyanya	1969	29.2	-
Kigabagaba	1969	10.7	-
Kiziramere	1969	7.7	-
Rugongi	1969	12.9	-
Rushozi	1969	15.4	-

* not included in total as part of the Kyoga Lakes Complex
** Sources: see text

Total annual yield: 95 500-214 200 t

Potential annual yield: 141 290-147 530 t
(not including small lakes and reservoirs)

Table 4. TOTAL CATCH, UGANDA, 1972-1986 ('000 t)

Water body	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Lake Victoria	32.2	32.3	23.8	156.6	9.2	15.7	14.3	12.0	10.0	17.0	13.0	17.0	44.8	45.6	56.0
Lake Albert	19.4	13.0	13.0	19.1	9.1	20.6	20.6	17.0	13.0	6.0	10.0	4.0	4.0	6.0	3.2
Albert Nile	4.1	4.2	3.0	7.2	3.3	1.8	5.7	4.5	3.2	3.0	1.0	4.0	1.9	1.6	1.6
Lake Kyoga	90.3	100.5	104.0	121.1	114.0	167.0	167.0	131.0	131.0	130.0	138.0	140.0	150.0	100.0	128.0
Lakes Edward/George Kazinga Channel	11.7	11.0	10.0	13.6	9.0	12.1	11.8	9.6	7.0	5.0	6.9	6.0	10.4	6.6	8.0
Lake Wamala	3.9	4.3	6.0	6.5	4.0	1.1	1.8	2.0	1.0	3.8	-	-	-	-	-
Other waters	3.8	4.0	8.2	4.7	3.3	1.2	1.1	1.8	0.7	3.0	1.1	1.3	1.2	1.0	0.8
Total	166.0	169.5	167.0	188.0	152.0	219.5	223.3	179.9	165.9	167.8	170.0	172.3	212.3	160.8	197.6

Source: Fisheries Department, Entebbe, Govt. of Uganda, cited in TDRI 1983 (1972 to 1981)
Statistisches Bundesamt Länderbericht Uganda 1988 (1982 to 1986)

TDRI ESTIMATES FOR 1983
(TDRI, 1983)

Fishery	Annual prod. (t)	Potential prod. (t)
Lake Albert	6 000	12 000
Lakes Edward/George	6 500	11 000
Lake Kyoga	35 000	65 000
Lake Victoria	22 000	45 000
Lake Wamala	2 000	4 000
Albert Nile	4 000	6 000
Minor waters	2 000	4 000
Aquaculture	200	3 000
Total	77 700	147 000

4. STATE OF THE FISHERY

4.1 Yield (after Balarin, 1985c)

Official statistics (Tables 2, 4) show a steady rise in overall landings to a peak of 232 000 t in 1978, falling to 172 000 t in 1983. Lake Kyoga provided from 54 to 79% of the catch.

It is also reported that 15 000 canoes, averaging four fishermen per canoe, support at least 40 000 families. Government figures even suggest the existence of 20 000 fishermen dependent on lake and river fisheries - about 100 000 or more families.

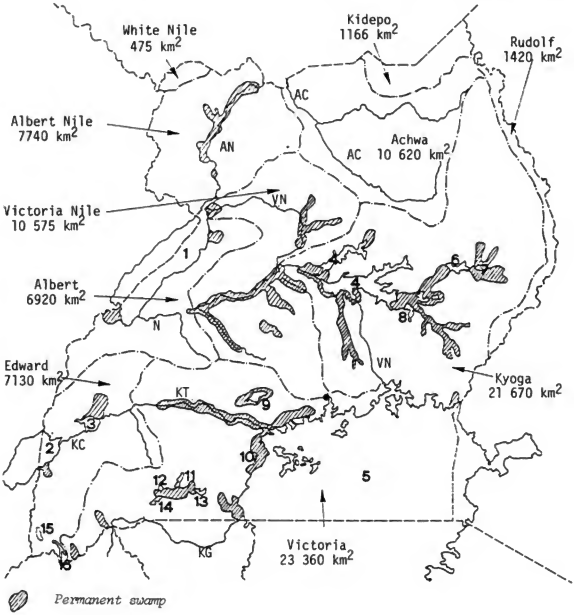
TDRI (1983) re-examined the statistics and considers the 1982 catch to average only 78 000 t. A significant source of error was considered to be the Lake Kyoga statistics (estimated to be exaggerated by 91 000 t). Reduction in the individual size of the Nile perch emphasized overfishing. Considering that efforts to rehabilitate the fisheries will increase production, and assuming the development of a recently established Nile perch fishery in Lake Victoria, target yields were set at 147 000 t. It is of interest to note that Nile perch stocked into Lake Kyoga in 1954 now yields over half of the catch (FAO, 1982b). Lake Victoria, stocked in 1960, now yields 30% of the catch (TDRI, 1983).

It is likely that the Nile perch fishery has developed at the expense of the smaller species stocks and therefore the potential might more closely approximate the lower yield targets of 147 000 t/yr. However, the fishery in Uganda has not been examined critically for some time and there is an urgent need for an updated stock assessment.

4.2 Factors influencing yield

All the major fisheries have extensively declined over the past decade, but there is no reliable data to develop an accurate status of the situation. TDRI (1983) indicates substantial reduction in net size and number, and a decrease in motorized boats. Statistics in the 1970's showed 20-25 nets per canoe on Lake Kyoga, but this is now reduced to only seven. Reduced catch has meant that a large portion of the fishermen are now also engaged in agriculture (Balarin, 1985c).

The Lake Victoria potential yield figure has been inflated by TDRI (1983) in anticipation of continued high production of Nile perch over the next few years; after a period of some years (possibly as short as 5-10 years) production is anticipated to fall off to around 35 000 t (TRDI, 1983).



LAKES

1 Albert (Mobutu Sese Seko)
2 Edward (Idi Amin Dada)
3 George
4 Kyoga/Kwania
5 Victoria
6 Bisina (Salisbury)
7 Opeta
8 Nakuwa
9 Kamala
10 Nabugabo
11 Kachira
12 Mburo
13 Kinjanebalala
14 Nakivali
15 Mutanda
16 Bunyoni

RIVERS

AC Achwa River
AN Albert Nile (White Nile)
KC Kazinga Channel
KG Kagera River
KT Katonga River
VN Victoria Nile (White Nile)

Fig. 1. LAKES, RIVER BASINS, SWAMPS AND RIVERS OF UGANDA
(after Balarin, 1985c)

4.3 Future development possibilities (after TDRI, 1983)

While it is accepted that production can be increased by inputs of gear and engines, TDRI (1983) do not consider it realistic to expect a return to the very high production level of 223 000 t recorded in the official statistics for 1978. To obtain the recommended yield proposed will demand the capability to monitor and manage the fisheries. Many of the fisheries will soon become heavily exploited, and heavy overfishing could lead to a serious loss of production that would take many years to recover.

5. KEY BIBLIOGRAPHY

Balarin, 1985c

6. WATER BODIES DIRECTORY

Lakes

Albert (Mobutu)
Bisin A (Salisbury)
Bunyoni
Edward (Idi Amin)
George
Kachira
Katwe
Kayumba
Kijanebalola
Kwania
Kyahafi
Kyamwiga
Kyoga Lakes Complex
Mulehe
Mburo
Mutanda
Nabugabo
Nakivali
Nyabihoko
Nyamusingire
Opeta
Saka
Victoria
Wamala
Volcanic Crater Lakes of Western Uganda

Rivers

Kagera
Kazinga Channel
Semliki
Turkwel
White Nile

Reservoirs

Kanyanya
Kigabagaba
Kiziramere
Rugongi
Rushozi

LAKE ALBERT (= MOBUTU)
(International water)

Geographical data (see Fig. 2)
Location: Uganda, Zaire - 1°9'-2°17'N; 30°25'-31°25'E
Altitude: 618 m
Surface area: 5 270 km^2 total; Uganda: 2 850 km^2 (54%); Zaire: 2 420 km^2 (46%)
Depth: 58 m (max); 25 m (mean)
Volume: 140 km^3 total; 80 km^3 in Uganda
Max. length: 160 km
Max. width: 35 km
Major inflowing rivers: Semliki, Victoria Nile
Outflowing rivers: Albert Nile (Uganda)

LAKE ALBERT (cont.)

Physical and chemical data

Conductivity: K_{20} 675-730 μS/cm

Surface temperature: 26-29°C

pH: 8.4-9.5

Oxygen: rich in oxygen at all depths

Dissolved solids (mg/l):
565 (mean); 518-672 (Lake); 370-680 (Semliki Delta)

Ionic composition:

	(Van Der Ben, 1959)	(Talling & Talling, 1965)
	mg/l	mg/l
Na	97.0	91.0
K	66.0	65.0
Ca	9.8	9.8
Mg	31.5	32.1
HCO_3+CO_3	475.8	445.3
Cl	31.0	31.0
SO_4	25.0	32.0
SiO_4	3.4	0.09-0.9
	μg/l	μg/l
NO_3-N	9.0	-
PO_4-P	130.0	-
Total P	-	200.0

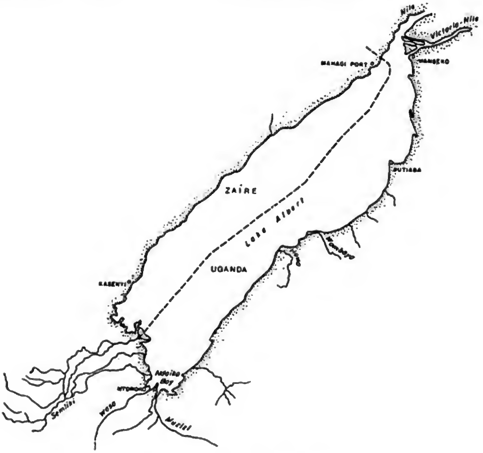


Fig. 2. LAKE ALBERT/MOBUTU
(after Welcomme, 1972)

LAKE ALBERT (cont.)

Fisheries data

No. of fish species: 46 (Greenwood, 1964)

Main catches: 75 to 85% of catches are:
Characidae: *Alestes baremose*, *Hydrocynus forskahli*
Centropomidae: *Lates niloticus albertianus* (Proude, 1984)

No. of boats: In Uganda:
860 in 1970
1 300 in 1983

Total catch: In Uganda:

Year	Tons	
1955	3 800	
1957	9 000	
1960	12 311	
1961	11 878	
1962	11 000	
1963	10 268	
1964	10 042	
1965	12 032	
1966*	13 382	(including Semliki River and Albert Nile)
1967	12 981	(including Semliki River and Albert Nile)
1968	12 000	
1969	7 449	
1970	9 530	
1971	9 500	
1972	19 400	
1973	13 000	
1974	13 000	
1975	19 100	
1976	9 100	
1977	20 600	
1978	20 600	
1979	17 000	
1980	13 000	
1981	6 000	
1982**	10 000	
1983	4 000	
1984	4 000	
1985	6 000	
1986	3 200	
1987***	15 000	(estimate for entire lake)

Sources:
* 1966-81: Fisheries Department, Entebbe, Govt. of Uganda, cited in TDRI, 1983
** 1982-86: Statist. Bundesamt Länderbericht Uganda, 1988
*** Giudicelli *et al.*, 1987

Potential annual yield:
in Uganda: 18 240 t (64 kg/ha - Giudicelli *et al.*, 1987)
in Uganda: 12 000 t (42 kg/ha - TDRI, 1983)

total lake: 25 000 t (47 kg/ha - Proude, 1984)
(13 500 t in Uganda; 11 500 t in Zaire)
total lake: 34 000 t (64 kg/ha - Giudicelli *et al.*, 1987)

Key reference for Lake Albert (Mobutu): Proude, 1984

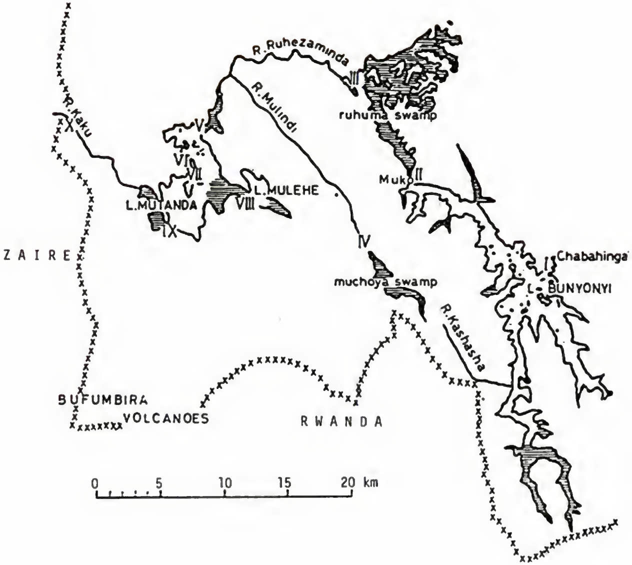


Fig. 3. LAKE AND RIVER SYSTEM IN S.W. KIGEZI
(after Visser, 1962)

LAKE BISINA (= SALISBURY)

Geographical Data

Location: Uganda - 1°38'N; 33°57'E
Max. length: 30 km
Max. width: 11 km (mean: 7 km)
Surface area: circa 150 km^2
Inflowing river: Lochomon
Special features: Part of Kyoga Lakes complex

Physical and chemical data (Talling & Talling, 1965)

Conductivity: 365 μS/cm

Fisheries data

Total annual catch: 2 000 t in 1960; 984 t in 1969

LAKE BUNYONI

Geographical data:

Location: Uganda - 1°18'S; 29°54'E (see Figs. 1, 3)
Altitude: 1 973 m
Surface area: 57 km^2 (Welcomme, 1972)
Depth: 39.3 m (max)
Max. length: 24 km
Outflowing river: Ruhuma
Special features: The Ruhuma River, into which Lake Bunyoni discharges, goes into the Ruhuma Swamps (90 km^2), a wide swampy valley with papyrus as main vegetation (Visser, 1962).

Physical and chemical data

Conductivity: 99-135 μS/cm (EAFRO, 1954)
260-262 μS/cm (Talling & Talling, 1965)
275-300 μS/cm (Visser, 1962)
Surface temperature: 21-22°C
pH: 7.0-7.2 (EAFRO, 1954)
8.0-9.3 (Talling & Talling, 1965)
7.7-7.8 (Visser, 1962)
Alkalinity: N x 10^{-4} 12-19.8 (EAFRO, 1954)
Ionic composition:

	(EAFRO, 1954) mg/l	(Tall.& Tall., 1965) mg/l	(Visser, 1962) mg/l
Na	-	-	6.1
K	-	-	7.5
Ca	11.3-19.2	11.3	13.0
HCO_3+CO_3	-	73.2	-
Cl	6.0-18.0	6.0	2.2
SiO_2	2-4	2	-
NO_2-N	0.03	-	-
NO_3	-	-	1.07

LAKE EDWARD (= IDI AMIN)

(International water)

Geographical data (see Fig. 4)

Location: Uganda, Zaire - 0°04'-0°39'S; 29°20'-30°E

Altitude: 914 m

Surface area: Uganda: 670 km^2 (29%); Zaire: 1 630 km^2 (71%)
Total: 2 300 km^2

Depth: 117 m (max); 34 m (mean)

Volume: 78.2 km^3 - 90 km^3

Max. length: 90 km

Max. width: 40 km

Major inflowing rivers: Rutshuru (also connected to Lake George by the Kasinga Channel), Rwindi, Luholu, Ishasha

Outflowing river: Semliki

Physical and chemical data

Conductivity: K_{20} 900 μS/cm (EAFRO, 1954);
925 μS/cm (Talling & Talling, 1965)

Surface temperature: circa 26°C

Dissolved solids: 521 mg/l

pH: 8.5-9.3

Ionic composition: (Talling & Talling, 1965)

	mg/l
Na	110.0
K	9.0
Ca	12.4
Mg	47.3
HCO_3+CO_3	600.0
Cl	36.0
SO_4	31.0
SiO_2	6.5
	μg/l
NO_3-N	24.0
PO_4-P	18.0
Total P	127.0

Fisheries data

No. of fish species: 53, of which 28 are cichlids (Greenwood, 1964)

Main catches: (Jensen et al., 1983; and Vakily, 1989)

Tilapia	*(Oreochromis niloticus eduardianus)*	60-70%
Bagrus	*(Bagrus docmak)*	10%
Barbus	*(Barbus altianalis eduardianus)*	5%
Protopterus	*(Protopterus aethiopicus aethiopicus)*	10%
Clarias	*(Clarias gariepinus)*	10%

No. of boats: *in Zaire:* 700 canoes in 1988 (Vakily, 1989);
in Uganda (including Lake George): 878 in 1982 (TDRI, 1983)

Total catch: *in Uganda*

Miscellaneous sources

(Note: Due to the variety of sources and methods used, these estimates do not necessarily reflect the actual catches.)

Year	Tons
1955	2 500
1957	7 000*
1960	5 162
1961	6 342
1962	6 751

LAKE EDWARD (cont.)

Fisheries data (cont.)

Miscellaneous sources

Year	Tons
1963	6 464
1964	5 829
1965	7 846
1966	7 890
1967	
1968	12 808*
1969	11 826*
1970	5 700
1971	8 100
1972	7 000
1973	7 100
1974	6 600
1975	8 400
1976	7 700

----

* includes Lake George and Kazinga Channel

Definite sources (in tons)

Author	Year	Zaire	Uganda	Total Lake
Dunn, 1989	1961 to 1988	-	5 564 ± 2 265 (average)	-
Dunn, 1989	present	-	±4 000	-
Giudicelli *et al.*, 1987	1985	-	-	10 400
TDRI, 1983	1983	-	6 500*	-
Vakily, 1989	1988	10-11 000	3 000	14 000
Welcomme, 1972	1969-1970	10 351	5 731	16 082
Welcomme, 1979a	-	5 000	-	-
See Table 4	1972 to 1986	-	see Table 4*	-

* includes Lake George and Kazinga Channel

Potential annual yield: (in tons)

Author	Zaire	Uganda	Total Lake
Jensen *et al.*, 1983	15-20 000	-	-
Giudicelli *et al.*, 1987	-	-	13 000
Vakily, 1989	-	-	15-16 000
TDRI, 1983	-	11 000*	-
Dunn, 1989	10 000	4 000	14 000

* includes Lake George and Kazinga Channel

Key reference: for Lake Edward: Vakily, 1989

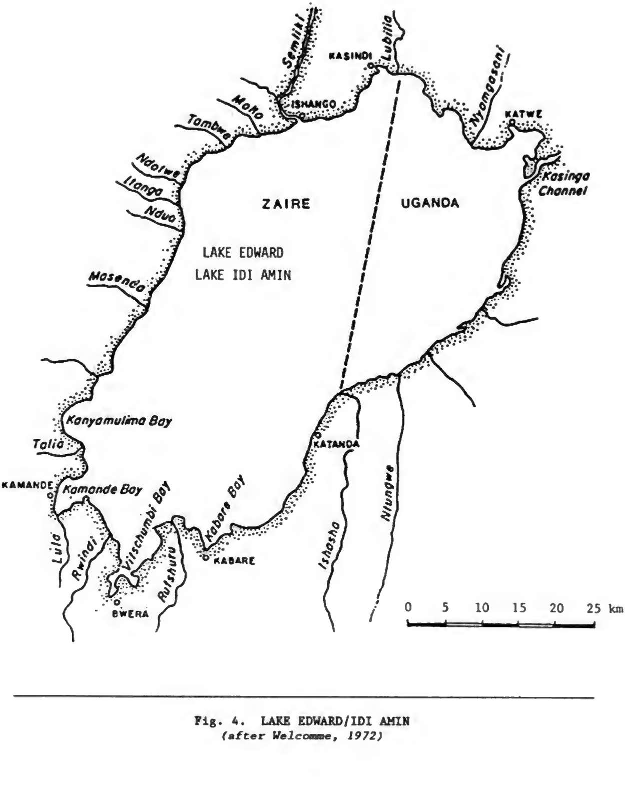


Fig. 4. LAKE EDWARD/IDI AMIN
(after Welcomme, 1972)

LAKE GEORGE

Geographical data (Welcomme, 1972)
Location: Uganda - 0°05'N-0°05'S; 30°02'-30°18'E
Altitude: 914 m
Surface area: 250 km^2
Depth: 7 m (max); 2.4 m (mean)
Volume: 0.5 km^3
Max. length: 23 km
Max. width: 18 km
Outflowing river: Kasinga Channel to Lake Edward
Catchment area: 9 000 km^2
Outflow: 53.5 $m^3 s^{-1}$

Physical and chemical data
Conductivity: K_{20} 165 (EAFRO, 1954) - 207 (Beadle, 1932) μS/cm
210 μS/cm (in wet season of October 1967) to
235 μS/cm (in dry season of July 1967) (Viner, 1969)
Surface temperature: 25-35°C
Dissolved solids: 264 mg/l (Hurst, 1925)
pH: 8.5-9.5 (Dunn *et al.*, 1969)
Oxygen: Surface waters: 250% saturation during day
below saturation during night
Bottom waters: below saturation (Burgis, 1987)
Ionic composition: (from Viner, 1969)

	Wet season July 1967 meq/l	Dry season Oct. 1967 meq/l
Na	0.89	0.85
K	0.114	0.097
Mg	0.6	0.64
Ca	0.722	1.0
HCO_3	1.25	2.0
Cl	0.215	0.26
SO_4	0.375	0.3
Mn μg/l	40.0	20.0
Fe (Total) μg/l	520	332
SiO_2 mg/l	20.5	20.0
Nitrogen:		
(total) mg/l	2.4	2.7
NO_2	0	0
NO_3 μg/l	0	28.4
NH_4+ μg/l	51	0
Phosphorous:		
total PO_4-P μg/l	200	240
soluble PO_4-P μg/l	42	18.5

Photosynthetic production: (cited in Beadle, 1981)
Chlorophyll a in euphotic zone: 70-280 mg/m^2
Photosynthetic (gross): 5.4 $gC/m^2 \cdot$day; 1 980 gC/m^2.year

Fisheries data
No. of boats: 878 canoes in 1982 (including Ugandan waters of Lake Edward) (TDRI, 1983)

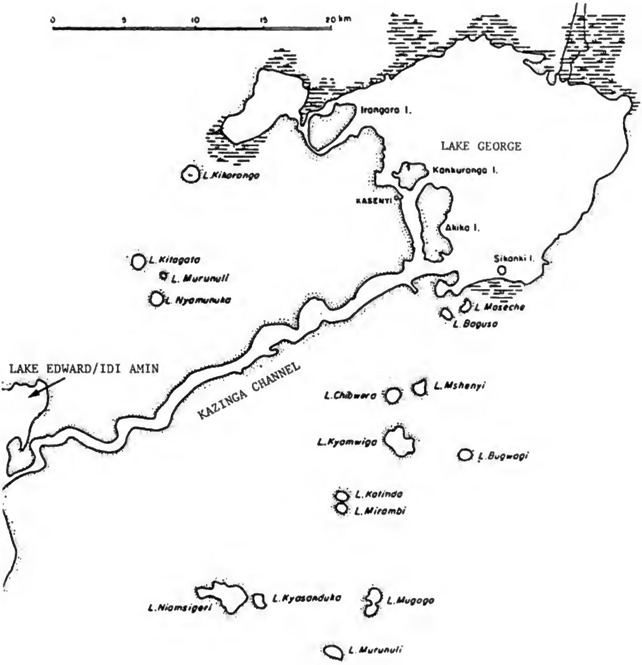


Fig. 5. LAKE GEORGE AND THE SURROUNDING CRATER LAKES
(Welcomme, 1972)

LAKE GEORGE (cont.)

Fisheries data (cont.)

Total catch:

Year	Tons
Miscellaneous sources	
1955	3 500
1957	7 000*
1960	5 021
1961	4 175
1962	5 133
1963	4 517
1964	4 245
1965	4 697
1966	3 250
1967	2 438
1968	12 808*
1969	3 950
1970	4 242
1971	2 800
1972	4 300
1973	2 800
1974	3 200
1975	4 400
1976	4 700

Definite sources		
1967	2 438	(Welcomme, 1972)
1969	3 950	(Welcomme, 1972)
1970	4 242	(Welcomme, 1972)
1972-1986	see Table 4	
1983	6 500*	
1950-88**	3 171 ± 1 093	(standard deviation) (Dunn, 1989)
1989	5 000	(Dunn, 1989)

---

* includes Lake Edward and Kazinga Channel

** average yield, 39-year period

Potential annual yield

TDRI, 1983: 11 000 t* (±116 kg/ha)
Kerr, 1966: 5 000 t
Dunn, 1989: 5 000 t

---

* includes Lake Edward and Kazinga Channel

LAKE KACHIRA

Geographical data:

Location:	Uganda - 0°35'S; 31°07'E
Altitude:	1 230 m (Worthington, 1932)
Surface area:	36.3 km^2 (Worthington, 1932)
Depth:	4.1 m (max) (Worthington, 1932)
Max. length:	20.0 km (Welcomme, 1972)
Max. width:	3.5 km (Welcomme, 1972)
Outflowing river:	Kibali discharging, via the Kagera River, into Lake Victoria
Special features:	part of a complex of lakes (Kachira, Kijanebalola, Nakivali, Mburo, etc.) and extensive papyrus swamp (Burgis *et al.*, 1987). The sizes and shapes of the lakes themselves vary from year to year (Worthington, 1932). (See Figs. 1, 6.)

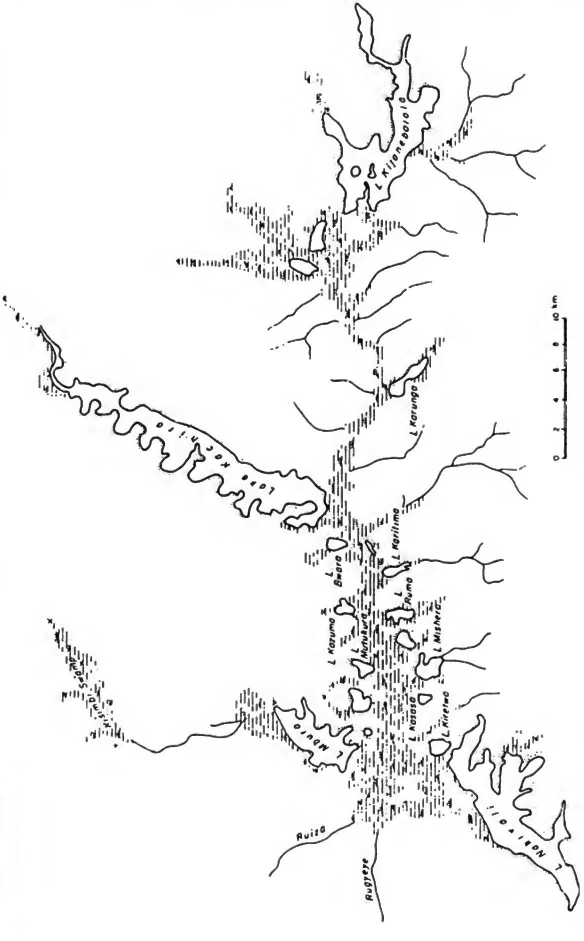


Fig. 6. THE ANKOKE AND KOKI LAKES OF UGANDA (Welcomme, 1972)

LAKE KACHIRA (cont.)

Physical and chemical data (Worthington, 1932)

Temperature:	25-26°C
pH:	8-8.4

Fisheries data

Fish species: indigenous in 1932: *Clarias* spp., *Haplochromis* spp.
introduced: various species of tilapia (Worthington, 1932)

Total catch:

Year	Tons
1960	1 014
1961	1 000
1962	1 000
1963	1 000
1964	1 086
1965	1 100
1966	1 100

LAKE KATWE

Geographical data

Location:	Uganda - 0°08'S; 29°52'E
Altitude:	895 m
Surface area:	2.45 km^2 (Melack, 1978)
Depth:	0.33 m (max) (Melack, 1978)
Max. length:	2.5 km
Max. width:	1.5 km
Special features:	shallow and concentrated saline crater lake. Sodium chloride is dominant and the lake has long been the centre of trade in salt, which is evaporated in pans along the shore. The salt has a distinctive pink colour. (Burgis, 1987)

Physical and chemical data (Melack, 1978)

Conductivity:	K_{20} 116 000-166 000 μS/cm
Temperature:	29.6°C
pH:	9.7

Ionic composition:

HCO_3+CO_3	1 544-2 400 meq/l
SiO_2	6.4 mg/l

LAKE KAYUMBA

Geographical data

Location:	Uganda - 1°20'S; 29°47'E
Max. length:	2 km
Max. width:	1 km

Fisheries data

No. of fishermen:	6 in 1969
Total catch:	7 t in 1969

LAKE KIJANEBALOLA

Geographical data
Location: Uganda - 0°42'S; 31°18'E
Altitude: 1 226 m (Worthington, 1932)
Surface area: 42 km^2
Depth: 4.8 m (max) (Worthington, 1932)
Max. length: 30 km
Max. width: 2 km
Outflowing river: Kibali discharging, via the Kagera River, into Lake Victoria. Overflow into the Kibali River happens about every 12 years (Worthington, 1932) and between such times the lake has no outlet.
Special features: part of a complex of lakes (Kachira, Kijanebalola, Nakivali, Mburo, etc.) and extensive papyrus swamp (Burgis, *et al.*, 1987). The sizes and shapes of the lakes themselves vary from year to year (Worthington, 1932). (See Figs. 1, 6.)

Physical and chemical data (Worthington, 1932)
Temperature: 23.3-24.8°C
pH: 8.3

Fisheries data
Fish species:
Main catches: *Haplochromis* spp.; also *Clarias*, *Protopterus*, *Oreochromis niloticus*, *O. esculentus*, *O. variabilis* (Okaronen, 1975b)
Total annual catch and effort:

Years	Tons
1960 to 1962	500
1963 to 1966	800

LAKE KWANIA

Geographical data (mainly cited in Burgis *et al.*, 1987)
Location: Uganda - 1°36'-56'N; 32°32'E (See Fig. 7)
Altitude: 1 033 m
Surface area: 508 km^2
Depth: 5.3 m (max); 4 m (mean)
Max. length: 69 km
Max. width: 5 to 8 km
Outflowing river: 20-km-long channel to Victoria Nile River
Special features: part of Kyoga Lakes complex

LAKE KYAHAFI

Geographical data
Location: Uganda

Fisheries data
No. of fishermen: 4 in 1969
Total annual catch: 4.5 t in 1969

LAKE KYAMWIGA

Geographical data

Location:	Uganda - 0°11'S; 30°08'E
Surface area:	2.6 km^2
Max. length:	2.5 km
Max. width:	1.5 km

KYOGA LAKES COMPLEX

Geographical data

Location:	Uganda - 1°-2°N; 32°20'-34°20'E (see Fig. 7)
Altitude:	1 033 m
Surface area:	2 700 km^2 (but varies with time) 4 735 km^2 of the Lake Kyoga catchment consists of swamps and lakes made up as follows: (Burgis, *et al.*, 1987)

Lakes	Area (km^2)
Kwania	508.1
Kyoga	1 821.6
Nakuwa	93.1
other small lakes	200.0
Total	2 622.8

Swamps	
Sezibwa	467.5
Naigombwa, Umpologoma and Manafwa	528.8
Lwere	29.4
Small lakes & swamps	404.4
Swamps of Lakes Kwania & Kyoga	386.3
Swamps between Olya and Lake Kwania	136.9
Swamps of Lake Victoria catchment	141.3
Total	2 094.6

Depth:	10 m (max); 2.26 m (mean) in Lake Kyoga, 1987/88 (Marriott *et al.*, 1988)
Max. length:	Lake Kyoga - 90 km (varies with time)
Max. width:	Lake Kyoga - 15 km (varies with time)
Major inflowing river:	White (Victoria) Nile
Outflowing river:	White (Victoria) Nile
Special features:	During years of high water level (i.e. 1965-71) the entire Kyoga complex becomes a confluent sheet of water; during years of low water (i.e. 1983) the complex breaks up into numerous distinct lakes. The largest are Lakes Kyoga and Kwania. Smaller lakes include Lakes Bisina (= Salisbury), Opeta, Nyaguo, Nyasala, Adois, Kadika, Kondo, Namasajeti, Naragaga, Nabigaga, Nawampasa, Nakuwa, Kawi and Lemwa.

Physical and chemical data - Lake Kyoga

Conductivity:	K_{20} (in 1988): 90 to 200 μS/cm, mean 128 μS/cm (Marriott *et al.*, 1988)
Surface temperature:	± 28.0°C
pH:	7.6-9.0

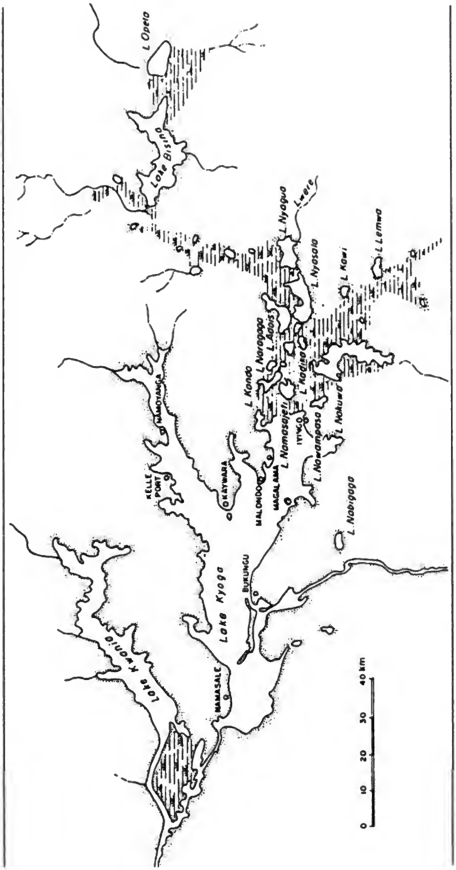


Fig. 7. LAKES OF THE KYOGA SYSTEM (after Welcomme, 1972)

KYOGA LAKES COMPLEX (cont.)

Physical and chemical data (cont.)

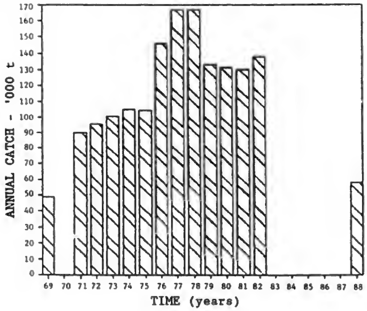
Ionic composition:

	(EAFRO, 1954)	(HYDROMET, 1974)
	mg/l	mg/l
Na	10.8	26.3
K	9.6	6.6
Ca	21.7	14.1
Mg	13.8	7.5
HCO_3+CO_3	133.0	
Cl	12.0	8.7
SO_4	31	2.9
SiO_2	34	
	µg/l	
NO_2-N	22	
PO_4-P	220	
Total P	272	

Fisheries data

Fish species: (cited from Marriott *et al.*, 1988)

Worthington (1929) reported 46 fish species, the majority of which occurred also in Lake Victoria. In order of economic importance, these are: *Oreochromis variabilis*, *O. esculentus*, *Bagrus docmac*, *Clarias mossambicus*, *Protopterus aethiopicus*, *Barbus altianalis*, *Schilbe mystus*. Also abundant: *Lates victorianus* and numerous species of Haplochromines.



1969 catch data from Welcomme (1972)
1971-81 catch data from Fisheries Dept. figures
1988 catch data from ADP Survey estimates

Fig. 8. KYOGA LAKES COMPLEX CATCH, 1969-1988
(Marriott et al., 1988)

KYOGA LAKES COMPLEX (cont.)

Fisheries data (cont.)

The introduction of *Oreochromis niloticus* and *Lates niloticus* (among others) between 1954 and 1957 produced the decline of most of the indigenous fish population. By 1969, these two introduced fishes comprised more than 80% of the total commercial catch.

The Kyoga fishery appears to have been most productive in the 1970's. A decline in the catch from the lake was noted in the early 1980's and by 1985 *L. niloticus* constituted less than 20% of the total commercial output. *O. niloticus* had become tha single dominant species in the fishery. It has been suggested that the use of seines in the shallow waters of Kyoga is partly responsible for the decline of the Nile perch.

No. of boats: (canoes)
2 200 (1961)
2 121 (1969)
4 371 (1970) (Fisheries Dept. Survey)
7 000 (1983) (TDRI, 1983)
3 459 ± 654 at 95% confidence (1987) (Marriott *et al.*, 1988)
No. of nets: 40 000 (Marriott *et al.*, 1988)
Total annual catch:

Miscellaneous sources

Year	Tons	Year	Tons
1955	3 000	1965	18 018
1956	4 500	1966	19 577
1957	5 000	1967	25 905
1960	13 210	1968	32 580
1961	12 866	1969	48 900*
1962	13 813	1970	62 100**
1963	16 755	1971	89 700
1964	18 261		

-----
* (Welcomme, 1972)
** includes White (Victoria) Nile River

Definite sources
1972-1986: see Table 4
1969-1988: see Fig. 8
1983 35 000 t (TDRI, 1983)
1988 57 000 t (Marriott *et al.*, 1988)

Potential annual yield: Lake Kyoga Complex: 65 000 t (TDRI, 1983)

LAKE MULEHE

Geographical data (* data from Burgis, 1987)
Location: Uganda - 1°13'S; 29°43'E (see Fig. 3)
Altitude: 1 750 m*
Surface area: 5 km^2*
Depth: 7.5 m (max)*
Outflow: discharges to Lake Mutanda via a papyrus swamp*

Physical and chemical data
Temperature: circa 20°C (Burgis, 1987)
Conductivity: 260 µS/cm (Talling & Talling, 1965)
275 µS/cm (Visser, 1962)

LAKE MULEHE (cont.)

Physical and chemical data (cont.)

pH: 7.4-8.0 (Talling & Talling, 1965)
7.3 (Visser, 1962)

Ionic composition: (Talling & Talling, 1965)

	mg/l
Na	10.8
K	9.6
Ca	20.8-21.7
Mg	13-13.8
Cl	12.0-14.2
SO_4	21-27
SiO_2	19.5-34
HCO_3+CO_3	2.10-2.18 meq/l
	μg/l
NO_3-N	22
PO_4-P	220-228
Total P	240-272

Fisheries data

No. of fishermen: 33 in 1969
Total annual catch: 27.76 t in 1969

LAKE MBURO

Geographical data

Location: Uganda - 0°40'S; 30°56'E (see Fig. 6)
Altitude: 1 230 m (Worthington, 1932)
Surface area: 10.4 km^2 (Worthington, 1932)
Max. length: 6 km
Max. width: 3 km
Inflowing river: Rinzi
Outflowing river: Kibali
Special features: part of a complex of lakes (Kachira, Kijanebalola, Nakivali, Mburo, etc.) and extensive papyrus swamp (Burgis *et al.*, 1987). The sizes and shapes of the lakes themselves vary from year to year (Worthington, 1932). In 1983 Lake Mburo was gazetted as a National Park (Burgis *et al.*, 1987).

Fisheries data

Fish species: indigenous in 1932:
Clarias spp., *Haplochromis* spp. (Worthington, 1932)
introduced: various species of tilapia
Potential annual yield:
National park since 1983; fishing restricted

LAKE MUTANDA

Geographical data

Location: Uganda - 1°12'S; 29°40'E (See Fig. 3)
Altitude: 1 790 m
Surface area: 23 km^2
Depth: 56 m (max) (Visser, 1962)
Inflowing river: Ruhezaminda
Outflowing river: Kaku River, through a papyrus swamp

LAKE MUTANDA (cont.)

Physical and chemical data (Talling & Talling, 1965)

Conductivity: K_{20} 200-230 μS/cm

pH: 7.8-8.5

Temperature: 21-22°C

Ionic composition:

	mg/l
Ca	25
HCO_3+CO_3	1
Cl	2.06
SiO_3	16

Fisheries data: no fishing in 1969

LAKE NABUGABO

Geographical data

Location: Uganda - 0°22'S; 31°54'E

Altitude: 1 136 m

Surface area: 30 km^2

Depth: 5 m (max)

Max. length: 8.5 km

Max. width: 5.0 km

Outflow: discharges to Lake Victoria through a sandbar

Physical and chemical data: June, 1967 (Beadle, 1981):

Conductivity: 25 μS/cm

pH: 7-8.2

Ionic composition:

	meq/l
Na	0.090
K	0.028
Ca	0.060
Mg	0.020
HCO_3+CO_3	0.140
Cl	0.040
SO_4	0.019

Fisheries data

Fish species: (After Greenwood, 1965, and Burgis et al., 1987)

9 indigenous species: *Haplochromis* (4 endemic), *Protopterus aethiopicus, Alestes nurse, Clarias mossambicus, Bagrus docmac, Schilbe mystus*, and *Synodontis afro-fischeri*. *Gnathonemus longibarbis* and *Clarias werneri* are restricted to the swamps.

Introduced in the 1950's:

Oreochromis niloticus, O. Leucostictus, Tilapia zillii.

LAKE NAKIVALI

Geographical data (see Fig. 6)

Location: Uganda - 0°47'S; 30°53'E

Altitude: circa 1 230 m

Surface area: 26 km^2 (Worthington, 1932)

Depth: 3.5 m (max) (Worthington, 1932)

Max. length: 14 km

Max. width: 6 km

Outflowing river: Kibali, discharging via the Kagera River into Lake Victoria

LAKE NAKIVALI (cont.)

Geographical data (cont.)
Special features: part of a complex of lakes (Kachira, Kijanebalola, Nakivali, Mburo, etc.) and extensive papyrus swamp (Burgis *et al.*, 1987). The sizes and shapes of the lakes themselves vary from year to year (Worthington, 1932).

Physical and chemical data (Worthington, 1932)
Temperature: 24.8-25.9° C
pH: 7.7-8.5

Fisheries data
Fish species: indigenous in 1932:
Clarias spp., *Haplochromis* spp. (Worthington, 1932)
introduced: various species of tilapia
Total annual catch:

Year	Tons	Year	Tons
1960	655	1964	986
1961	600	1965	109
1962	895	1966	274
1963	551		

LAKE NYABIHOKO

Geographical data
Location: Uganda

Fisheries data
No. of fishermen: 30 in 1969
Total annual catch: 150 t in 1969

LAKE NYAMUSINGIRE

Geographical data (Melack, 1978)
Location: Uganda - 0° 17'S; 30° 02'E
Altitude: 975 m
Surface area: 4.4 km^2
Depth: 4.9 m (max)
Shoreline: 3.75 km
Special feature: Crater lake

Physical and chemical data (Melack, 1978)
Conductivity: 875-908 µS/cm
Temperature: 24.6° C (near bottom)
pH: 8.7-9.1
Oxygen: 118% surface
Ionic composition:

	mg/l
Ca	37.0-54.4
Mg	41.0
SiO_2	32.1-124
HCO_3+CO_3	10.1-10.8 meq/l
PO_4	3 400-4 200 µg/l

Fisheries data
Total annual catch: 52.7 t in 1969

LAKE OPETA

Geographical data
Location: Uganda - 1° 39'N; 34° 11'E
Surface area: 42 km^2
Max. length: 10 km
Max. width: 6 km
Special features: Part of Kyoga Lakes Complex

LAKE SAKA

Geographical data (Melack, 1978)
Location: Uganda - 0° 42'N; 30° 14'E
Altitude: 1 520 m
Surface area: 1.1 ha
Depth: 8.5 m (max); 2.7 m (mean)
Shoreline: 430 m
Special feature: Crater lake

Physical and chemical data (Melack, 1978)
Conductivity: 533 μS/cm
Temperature: 21° C near bottom
pH: 7.2
Oxygen: 157% at 0.5 m

Ionic composition		mg/l
	Ca	54-57
	Mg	31-33.4
	SiO_2	30-42
	HCO_3+CO_3	7.0-7.5 meq/l
	PO_4	100 μg/l

Fisheries data
No. of fishermen: 2 in 1969
Total annual catch: 5 t in 1969

LAKE VICTORIA
(International water)

Geographical data (Welcomme, 1972) (see Fig. 9)
Location: Kenya, Tanzania, Uganda
0° 20'N-3° 0'S; 31° 39'-34° 53'E
Altitude: 1 136 m

Surface area:			
	Kenya	4 100 km^2	(6%)
	Tanzania	33 700 km^2	(49%)
	Uganda	31 000 km^2	(45%)
	Total	68 800 km^2	

Depth: 84 m (max); 40 m (mean)
Max. length: 400 km
Max. width: 240 km
Shoreline: 3 440 km
Catchment area: 263 000 km^2
Major inflowing rivers: Kagera, Nzoia, Yala
Outflowing river: Victoria Nile

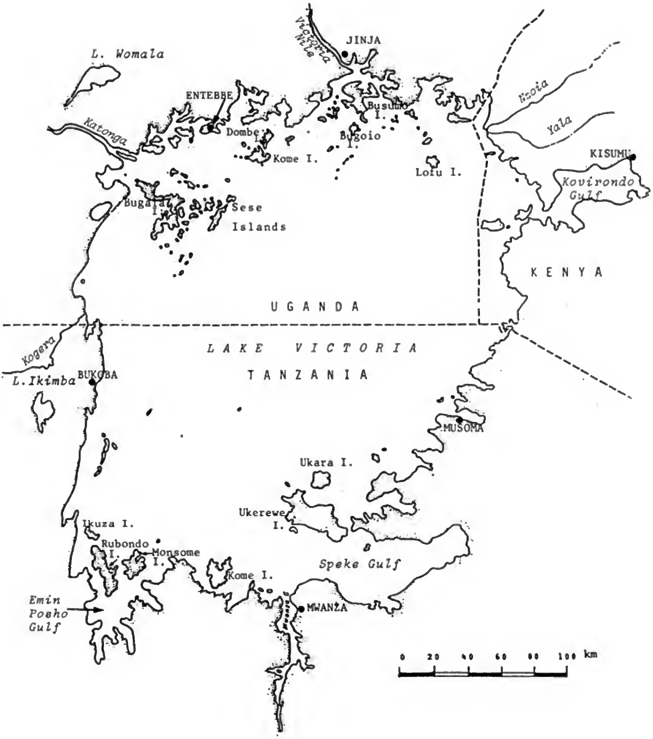


Fig. 9. LAKE VICTORIA
(Welcomme, 1972)

LAKE VICTORIA (cont.)

Physical and chemical data

Conductivity: K_{20} 91* to 98** µS/cm (*EAFRO, 1952b) (**EAFRO, 1954)

Surface temperature: 23-28° C

Dissolved solids: 97 mg/l

pH:

Kavirondo Gulf: 8.2 (Talling & Talling, 1965)
9.0 (Graham, 1929)

Open lake: 8.0 (Talling & Talling, 1965)
8.5 (Graham, 1929)

Ionic composition:

	(EAFRO, 1952b)	(Talling & Talling, 1965)
	mg/l	mg/l
Na	12.5-13.5	10.4
K	3.7-4.2	3.8
Ca	5.0-7.0	5.6
Mg	2.3-3.5	2.6
HCO_3+CO_3	61.0-67.1	54.9
Cl	-	3.9
SO_4	0.8	-
SiO_2	3.9	4.2
	µg/l	µg/l
NO_3-N	-	11
PO_4-P	-	13
Total P	-	47

Fisheries data

No. of fish species: 177, of which 127 are cichlids (mostly *Haplochromis* species) (Greenwood, 1964)

Introduced:

-in the 1950's:
Oreochromis niloticus, *O. leucostictus*, *Tilapia zillii*, *T. rendalli*;

-in late 1950's, beginning 1960's:
Lates niloticus

In the 1960's and 1970's, *Haplochromis* species constituted an estimated 80% of the lake's fish biomass (FAO, 1973).

In the late 1970's and in the 1980's, the Nile perch *L. niloticus* population increased extremely, to the detriment mainly of the *Haplochromis* population. (see Table 6, underlined)

From data provided by the Fisheries Department between 1971 and 1975, the relative importance of the Nile Perch increased as follows: (TDRI, 1983)

Year	Nile Perch % of total catch	
1971	0.3	
1972	1.0	
1973	3.0	
1974	5.0	
1975	16.0	
1982/83	30.0	(TDRI 1983 estimate)

It is anticipated that the Nile Perch population will decrease as the *Haplochromis* stocks become seriously depleted. (TDRI, 1983)

No. of boats: In Uganda: 2 643 canoes in 1970
2 900 canoes in 1983 (TDRI, 1983)

Main catches: see Table 5

LAKE VICTORIA (cont.)

Table 5. MAIN FISH CATCHES IN UGANDA, 1975, 1979
(after Reynolds & Greboval, 1988)

Species	1975 (t)	1979 (t)
O.esculentus	70	180
O.niloticus	5 890	750
Other tilapia	1 040	720
Bagrus	2 930	6 530
Lates	250	190
Protopterus	195	1 370
Haplochromis	1 690	1 550
Clarias	2 584	3 029
Barbus	260	360
Synodontis	70	2 540
Mormyrus	40	130
Labeo	10	40
Schilbe	-	-
Rastrineobola	10	70
Other small mixed	-	-
TOTAL	15 500	16 760

Sources: CIFA, 1981; DFK Statistical Bulletins; Bwathondi, 1988.

Note: No figures are available for Uganda for 1985.

Table 6. LAKE VICTORIA - TOTAL FISH PRODUCTION (t), 1975, 1979, 1985
(after Reynolds & Greboval, 1988)

Species	1975	%	1979	%	1985*	%
O.esculentus	3 690	4.8	94	2.2		
O.niloticus	6 092	7.9	3 320	3.2	20 093	10.7
Other tilapia	3 509	4.6	6 355	6.0		
Bagrus	10 146	13.2	13 482	12.8	9 276	4.9
Lates	301	0.4	4 476	4.3	87 637	46.7
Protopterus	7 844	10.2	6 445	6.1	4 200	2.2
Haplochromis	22 458	29.2	29 909	28.4	11 578	6.2
Clarias	6 382	8.3	7917	7.5	6 107	3.3
Barbus	775	1.0	1 141	1.1	515	0.3
Synodontis	2 491	3.2	7 356	7.0	9 278	4.9
Mormyrus	178	0.2	897	0.9	402	0.2
Labeo	1 719	2.2	7 332	7.0	544	0.3
Schilbe	1 069	1.4	1 958	1.9	1 582	0.8
*Rastrineobola***	4 558	5.9	10 989	10.4	25 866	13.8
Other small mixed	5 707	7.4	1 419	1.3	10 417	5.6
TOTAL	76 919		105 267		187 495	

Sources: CIFA, 1981; DFK Statistical Bulletins; Bwathondi, 1988.
* Figures for 1985 combine Kenya and Tanzania only.
** Tanzania combines *Rastrineobola* with "Other small mixed".

LAKE VICTORIA (cont.)

Fisheries data (cont.)
Total annual catch:

Miscellaneous sources:

Year	Tons	Year	Tons
1955	10 550	1965	24 000
1957	22 800	1966	27 600
1960	22 700	1967	-
1961	23 000	1968	-
1962	23 500	1969	46 177
1963	24 000	1970	34 800
1964	24 000	1971	38 070

Definite sources:

1983	22 000 (TDRI, 1983)
1972 to 1986	see Table 4

Potential annual yield: in Uganda: 45 000 t (14.5 kg/ha; TDRI, 1983)

LAKE WAMALA

Geographical data

Location:	Uganda - 0° 20'N; 31° 53'E
Surface area:	244 km^2
Depth:	<9 m (max)
Max. length:	28 km
Max. width:	17 km

Fisheries data
Fish species:
Main catches: *Oreochromis niloticus* (introduced), *O.leucostictus*, *Tilapia zillii*, *Clarias* sp., *Protopterus* sp. (Okaronen, 1975, cited by Burgis et al., 1987)
No. of boats: 250 in 1975 (Okaronen, 1975a)
250 in 1983 (TDRI, 1983)
Total annual catch: 1972-1981: see Table 4
1983: 2 000 t (TDRI, 1983)
Potential annual yield:
4 000 t (164 kg/ha - TDRI, 1983)

VOLCANIC CRATER LAKES OF WESTERN UGANDA

In the Rift Valley and on the neighboring uplands in western Uganda there are four clusters of volcanic craters containing a total of 89 lakes.

Melack (1978) reported the results of a limnological survey of 16 of these volcanic crater lakes. The following data are taken from Melack, 1978.

> "The lakes range in latitude from 0° 42'N to 0° 19'S and vary in altitude from 1 520 to 895 m above sea level.
>
> "Based on the concentration of dissolved salts in the surface waters the lakes can be divided into a concentrated saline group (electrical conductivity >15 000 μS/cm at 20° C) and a dilute group (electrical conductivity <1 000 μS/cm at 20° C). All the lakes were alkaline, and the pH of their surface waters ranged from about 7.5 to about 10.2.

Table 7. MAIN FEATURES OF SOME CRATER LAKES, UGANDA
(after Melack, 1978)

Lake	Location		Altitude (m)	Lake area (ha)	Depth		Water temp. near bottom (°C)	Conductivity surface K_{20} µS/cm	pH surface
					max (m)	mean (m)			
Kanyangeye 1/ (unnamed on map)	0° 42'N	30° 15'E	1 520	0.5	57	34	20.9	456	8.5
Saka Crater 1/	0° 42'N	30° 14'E	1 520	1.1	8.5	2.7	21.0	533	7.6
Katanda 2/	0° 29'N	30° 16'E	1 340	35	146	-	21.9	375	8.8
Mwengenyi 2/	0° 29'N	30° 16'E	1 390	30	101	-	-	330	9.0
Kifuruka 2/	0° 29'N	30° 17'E	1 400	15	c.4	-	22.0	288	7.5
Mwamba 2/	0° 28'N	30° 17'E	1 220	48	39?	-	-	387	8.7
Lugembe 2/	0° 27'N	30° 17'E	1 300	7.5	20	12.2	22.2	306	8.7
Kikorongo 3/	0° 00'N	30° 01'E	925	103	8.5	-	24.6	16 800	10.0
Mahega 4/	0° 01'S	28° 58'E	925	16	4.1	-	37.2	112 200	10.1
Bunyampaka 3/	0° 02'S	30° 08'E	895	43	0.25	-	31.5	80 000	10.2
Katwe 4/	0° 08'S	29° 52'E	895	245	0.33	-	29.6	160 500	9.7
Chibwera 3/	0° 09'S	30° 08'E	975	78	12.5	-	24.7	431	7.8
Nyamusingire 5/	0° 17'S	30° 02'E	975	440	4.9	-	24.6	875	9.1
Nyungu 5/	0° 15'S	30° 06'E	1 220	20	18	10.0	22.0	431	9.2
Kamweru 5/	0° 15'S	30° 07'E	1 160	25	33.5	22.7	22.2	129	9.1
Nkugute 5/	0° 19'S	30° 06'E	1 220	105	58	20	21.5	86	8.5

1/ Bundibugyo, Uganda. 1:50 000. (Series Y732, sheet 56/3. Uganda Government 1964)
2/ Kahunge, Uganda. 1:50 000. (Series Y732, sheet 66/2, edition 3-U.S.D. Uganda Government 1969)
3/ Katanguru, Uganda. 1:50 000 (Series Y732, sheet 76/1, edition 4-U.S.D. Uganda Government 1965)
4/ Katwe, Uganda. 1:50 000. (Series Y732, sheet 75/2, edition 3-U.S.D. Uganda Government 1965)
5/ Rubirizi, Uganda. 1:50 000. (Series Y732, sheet 76/3, edition 3-U.S.D. Uganda Government 1965)

VOLCANIC CRATER LAKES (cont.)

"The midday temperatures of the surface waters ranged from 22.5 to 26.65° C in the dilute lakes and from 26 to 33° C in the saline lakes. In the lakes with persistent thermoclines the temperatures of the water near the bottom varied from 20.9° C (Lake Kanyangeye) to 24.75° C (Lake Chibwera) and tended to be higher in lakes at lower altitudes. In the lakes over 5 m deep both transient, superficial and persistent, deep-seated thermoclines existed.

"The hypolimnia were anoxic in all the lakes over 5 m deep, and the depth at which the deoxygenated water began coincided with the persistent thermoclines but varied more than was expected."

Table 7 summarizes the main features of the 16 lakes. Fisheries data are not available.

See Lakes Nyamusingire, Saka and Katwe for more details on their characteristics.

KAGERA RIVER
(International Water)

Geographical Data
Source: Burundi/Rwanda
Total length: 785 km
Countries traversed: Burundi, Rwanda, Tanzania, Uganda
Main tributaries: Akanyaru, Nyabarongo, Ruvubu
Discharges to: Lake Victoria
Special features:

(1) Upper Kagera Lakes Complex. A group of lakes distributed as follows:
In Burundi: Ingitamo, Kacamurinda, Kanzigiri, Lirwihinda, Rungazi;
In Rwanda: Birira, Gaharwa, Gashanga, Kidogo, Kirimbi, Mirayi, Mugesera, Muhazi, Murago, Sake;
International waters (Burundi/Rwanda): Cyohoha South, Rugwero.

(2) Rusumo Falls in Rwanda.

(3) Lower Kagera Lakes Complex and Floodplain/Swamp. A group of lakes and adjacent floodplain/swamp lakes distributed as follows:
In Rwanda: Chuju, Hago, Ihema, Iwapibali, Kishanja, Kivumba, Mihindi, Muhari, Nasho, Ngerenke, Rukira, Rwakibare, Rwampanga, Rwanyakizinga, Rwehihama, Sekena;
Floodplain/swamp area in Rwanda is circa 1 000 km^2
In Tanzania: Bisongo, Kajumbura, Lwelo, Mujunju, Rushwa.

Note: also called "Akagera".

Physical and chemical data (Kiss, 1977a)
Conductivity: K_{25} 111 μS/cm
pH: 7.01
Ionic composition:

	mg/l
Na	4.1
K	1.0
Ca	4.60
Mg	4.90
Cl	7.40
HCO_3-CO_3	42.70
Fe	0.30

KAZINGA CHANNEL (RIVER)

Geographical data

Source: Lake George
Altitude: 914 m
Total length: 25 km
Area of water: 25 km^2
Countries traversed: Uganda
Discharges to: Lake Edward
Volume of discharge at mouth: downstream flow very sluggish
Special features: channel connecting Lake George to Lake Edward (see Fig. 5)

Fisheries data

Total annual catch:

Miscellaneous sources

Year	Tons
1955	2 500 (includes Lake Edward)
1957	7 000*
1968	12 808*
1969	11 826*
1970	-
1971	900
1972	900
1973	400
1974	400
1975	500
1976	500

Definite sources

1983	6 500* (TDRI, 1983)
1972-1986	see Table 4

----

* includes Lakes George and Edward

Potential annual yield:

11 000 t (includes Lakes George and Edward)
(116 kg/ha - TDRI, 1983)
290 t (116 kg/ha - TDRI, 1983)

SEMLIKI RIVER
(International water)

Geographical data

Source: Zaire, Lake Edward
Altitude: 619 m
Countries traversed: Uganda, Zaire
Discharges to: Lake Albert

Physical and chemical data

Conductivity: K_{20} 400-910 µS/cm (Beauchamp, 1956)

Ionic composition:

	(EAFRO, 1952b)	(Van der Ben, 1959)
Ca	15 mg/l	-
HCO_3+CO_3	7.16 meq/l	7.3 meq/l
Cl	-	30.7 mg/l
SO_4	-	36.6 mg/l
SiO_2	24 mg/l	-

TURKWEL RIVER
(International water)

Geographical data

Source:	Mt. Elgon (Bukwa tributary)
Altitude:	4 322 m
Total length:	340 km (300 km in Kenya)
Countries traversed:	Kenya, Uganda
Major tributaries:	Suam (Bukwa), Morun
Discharges to:	Lake Turkana (3° 3'N; 36° 8'E)

WHITE NILE RIVER
(International water)

Geographical data (Welcomme, 1972)

The White Nile changes its name several times in its course: from Lake Victoria to Lake Albert it is known as the Victoria Nile; from Lake Albert to the Uganda border it is known as the Albert Nile; and from the Sudan to its confluence with the Blue Nile it is called the White Nile or Bahr el Abiad. (See Fig. 1)

Source:	Owen Falls dam, Uganda
Altitude:	1 136 m
Total length:	2 084 km (Albert Nile: 215 km) (Victoria Nile: 390 km)
Countries traversed:	Sudan, Uganda
Major tributaries:	Aswa, Bahr el Ghazal, Sobat, Semliki (via Lake Albert), Kagera (via Lake Victoria)
Discharges to:	Nile at Khartoum
Volume of discharge at mouth:	71 x 10^6 m^3/day The While Nile contributes 10% of the total flow during the summer floods and 83% at low water.
Special features:	Lake Kyoga, Kabalega, Murchison Falls, Lake Albert (Uganda) Sudd swamps (70 000 km^2), Jebel Aulia reservoir (Sudan)

Physical and chemical data (after Talling, 1957)

		Distance from source: Lake Victoria		
		800 km	1 200 km	2 000 km
Conductivity: K_{20}		180-230 μS/cm	190-240 μS/cm	150-180 μS/cm
pH:		7.9	7.1-7.3	7.2-7.8
Temperature: °C		28.0-29.0	27.0-28.0	24.0-28.5
Ionic composition:				
		mg/l	mg/l	mg/l
	Ca	7.0	7.0-9.0	8.0-10.0
	SiO_2	2.5-5	4-5.5	7.5-11.5
	Fe	0.1-0.3	0.4-1.4	0.2-0.7
	Cl	7.0-10.0	6.0-11.0	2.0-6.0
	SO_4	5.0	1.0	1.0
	NO_3-N	0.02-0.06	0.01-0.06	0.01-0.10
	NH_3-N	0.02-0.04	0.04-0.08	0.04-0.07
	PO_4-P	0.04-0.06	0.02-0.09	0.04-0.09

Fisheries data

No. of boats: Canoes on Albert Nile in Uganda:
667 in 1969;
957 in 1970;
2 640 in 1983 (Fisheries Department, Uganda)

WHITE NILE RIVER (cont.)

Fisheries data (cont.)

Total annual catch: Albert Nile in Uganda

Year	Tons	Year	Tons
1969	4 500	1978	5 700
1970	4 838	1979	4 500
1971	4 170	1980	3 200
1972	4 100	1981	3 000
1973	4 200	1982	1 000
1974	3 000	1983	4 000
1975	7 200	1984	1 900
1976	3 300	1985	1 600
1977	1 800	1986	1 600

Sources:

1969-1981: Fisheries Depart., Uganda

1982-1986: Stat.Bundesamt Länderbericht, Uganda, 1988.

Potential annual yield: 6 000 t - Albert Nile (TDRI, 1983)

KANYANYA RESERVOIR

Geographical data

Location: Uganda

Fisheries data

Total annual catch: 29.23 t in 1969

KIGABAGABA RESERVOIR

Geographical data

Location: Uganda

Fisheries data

Total annual catch: 10.71 t in 1969

KIZIRAMERE RESERVOIR

Geographical data

Location: Uganda

Fisheries data

Total annual catch: 7.69 t in 1969

RUGONGI RESERVOIR

Geographical data

Location: Uganda

Fisheries data

Total annual catch: 12.9 t in 1969

RUSHOZI RESERVOIR

Geographical data
Location: Uganda

Fisheries data
Total annual catch: 15.44 t in 1969

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ZAIRE

1. GEOGRAPHY AND CLIMATE (Welcomme, 1979a)

Zaire (surface area of 2 364 200 km^2) consists mainly of a low-lying central basin covered by tropical rain forest. The basin is surrounded by mountainous terraces in the west, elevated plateaus covered with savanna in the south and southeast, and dense grasslands in the north. The eastern region is crossed by high mountains.

Zaire lies astride the Equator, about one-third to the north and two-thirds to the south. The climate, therefore, is equatorial and especially hot and humid in the forested central areas. North of the Equator there is a single rainy season from April to November; south of it a rainy season lasts from October to May. In the central region rainfall is distributed evenly throughout the year.

Zaire is densely forested, and much of the central basin is occupied by tribes using primitive 'slash and burn' agriculture. In the western highlands cash crops such as coffee and cotton are common; in the south, in Shaba province, the considerable mineral resources have given rise to intensive mining development.

2. HYDROGRAPHY (adapted from Welcomme, 1979a) (See Fig. 1)

2.1 Lakes

The major lakes within Zaire are those of the Rift Valley and are found in the extreme east of the country (Tanganyika, Mweru, Kivu, Edward and Albert). In addition to these lakes, there are two major water bodies attached to the lower reaches of the river system: Lake Tumba and Lake Maji Ndombe (2 300 km^2). The Kamulondo Depression (Lualaba floodplain) contains some 50 lakes, of which Lake Upemba is by far the largest. Numerous small lakes are scattered throughout the country. The combined lake surface area is circa 28 000 km^2.

2.2 Rivers, Floodplains and Swamps

With the exception of parts of the Ubangi system and the upper reaches of some of the southern tributaries, almost the whole of the Zaire River basin lies within the country. The main channel of the Zaire is joined by such major tributaries as the Ubangi, Lualaba, Luapula, Lulonga, Tshuapa. There is a total of some 33 000 km of major river channel and their area (circa 34 000 km^2) is increased by intensive floodplains, particularly in the Kamulondo Depression and in the Mbandaka region of confluence between the Ubangi and the Zaire streams. In total, the floodplains are thought to cover about 50 000 km^2 during high water, but such a figure can only be approximate due to the difficulties in measuring such areas.

2.3 Reservoirs

Two major reservoirs have been installed in the southeast of the country: Mwadingusha on the Lufira, and Nzilo on the Lualaba.

2.4 Coastal Lagoons

None of significant size.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

In 1956 there were 94 761 ponds with a combined surface area of 3 863 ha. By 1960 this had increased to 120 000 ponds with an area of 4 200 ha.

In 1987, aquaculture production was estimated at about 700 t/yr (mainly *Oreochromis niloticus*) with possibilities of further development (Giudicelli *et al.*, 1987).

3.2 Fish production and per caput supply

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Zaire, 1970-1987

		Nominal Domestic Production (excluding exports) (t) 2/				Nominal Consumer Supply (excluding imports and exports) (kg/person)			
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Marine capture	Total	Inland capture	Aqua-culture 3/	Marine capture	Total
1970	19 481	121 900	- 4/	14 700	136 600	6.2	- 4/	0.75	7.0
1971	20 032	111 200	-	12 700	123 900	5.6	-	0.63	6.2
1972	20 600	111 200	-	13 000	124 200	5.4	-	0.63	6.0
1973	21 283	144 700	-	12 200	156 900	6.8	-	0.57	7.4
1974	21 782	115 430	-	13 380	128 810	5.3	-	0.61	5.9
1975	22 399	100 000	-	13 380	113 380	4.5	-	0.60	5.1
1976	23 050	110 000	-	7 858	117 858	4.8	-	0.34	5.1
1977	23 719	104 600	-	2 400	107 000	4.4	-	0.10	4.5
1978	24 408	107 600	-	1 106	108 706	4.4	-	0.05	4.5
1979	25 117	114 200	-	982	115 182	4.5	-	0.04	4.6
1980	25 847	101 800	-	615	102 415	3.9	-	0.02	3.9
1981	26 618	102 000	-	640	102 640	3.8	-	0.02	3.8
1982	27 412	100 000	-	700	100 700	3.6	-	0.02	3.6
1983	28 229	100 875	125	1 000	102 000	3.6	0.004	0.03	3.6
1984	29 071	146 275	125	1 900	148 300	5.0	0.004	0.06	5.1
1985	29 938	146 220	180	1 900	148 300	4.9	0.006	0.06	4.9
1986	30 862	163 311	689	2 000	166 000	5.3	0.022	0.06	5.3
1987	31 814	163 300	700 5/	2 000	166 000	5.1	0.022	0.06	5.2

1/ Source: FAO
2/ Source: FAO Fisheries Department FISHDAB
3/ included in "Inland capture" if not specified
4/ - = data not available
5/ Giudicelli, *et al.*, 1987

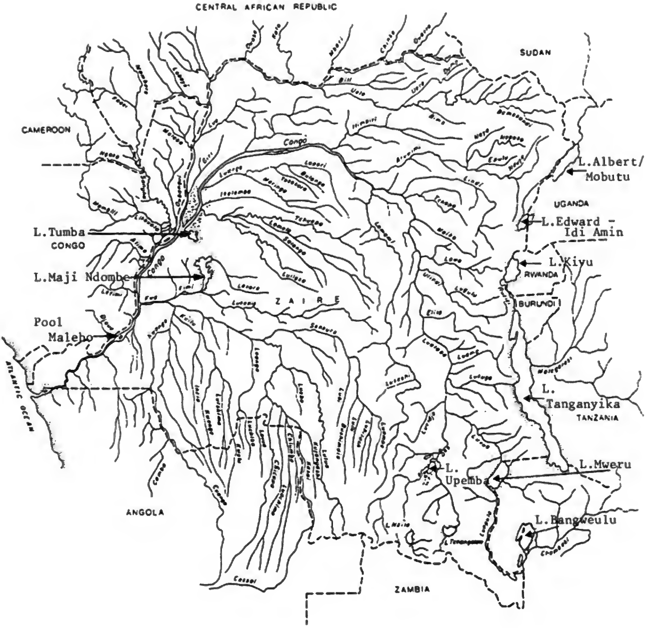

Fig. 1. **RIVERS AND LAKES OF THE CONGO/ZAIRE SYSTEM**
(Welcomme, 1972)

3.3 Inland catch range and potential yield

Table 2. INLAND CATCH RANGE AND POTENTIAL YIELD

Water body	Period	Annual catch range (t) 2/	Potential annual yield (t) 2/
Lakes	-	42 525-60 625	185 205-274 790
Albert/Mobutu	1982	5 000	11 500-15 640
Boya	-	-	-
Edward/Idi Amin	1982; 1979	3 500; 5 000	15 000
Kafakumba	-	-	-
Kasuku	-	-	-
Katania	-	-	
Kivu	1987	1 925	1 305-7 500
Libanda	-	-	-
Mai Ndombe	1982	1 000	5 750-10 000
Malebo (Pool)	1984	3 000-3 500	-
Mukamba	-	-	-
Mweru	1983	6 600-8 700	12 000
Tanganyika	1983-1988	16 000-30 000	135 000-210 000
Tumba	1982	500	2 000
Upemba	1981	5 000	2 650
Floodplains/Forests	-	12 000-13 000	91 600-129 500
Kamolondo/Lualaba	1981	10 000	30 000
Kifakula/Luapula	1983	2 000-3 000	5 000
Mai Ndombe	-	-	5 000-8 500
Mbandaka	-	-	15 600-26 000
Lisala Makanza	-	-	36 000-60 000
Reservoirs	-	3 220-3 430	6 960
Mwadingusha	1983	3 100	4 460
Nzilo	1983; 1981	120; 330	2 500
Rivers	1984	77 500-105 000	100 000 1/
Zaire	1961-1984	47 500-75 000	50 000 1/
Others	1961	30 000	50 000 1/
TOTAL (rounded)		130 000-180 000	380 000-510 000

1/ rough estimate based on several authors

2/ Sources: see text.

4. STATE OF THE FISHERY (adapted from Welcomme, 1979a)

4.1 Yield

Up to the early 1960's the catch from the inland waters of Zaire underwent a growth phase. During the early post-independence period many fisheries collapsed, recovered in the late 1960's and early 1970's, declined a second time, and increased again in the 1980's. The potential catch from all water bodies is between 380 000 and 510 000 t/yr.

4.2 Factors influencing yield

A considerable demand for fish in Zaire shows that the present low level exploitation is due to constraints on the marketing and distribution of fish. Many of the water bodies are isolated or inaccessible, and adequate fisheries will only be developed as infrastructures are built up.

4.3 Future development possibilities

It seems highly probable that the total catch of inland fish in Zaire will rise steadily over the next decade and that establishment of two specialized fisheries, in particular, will eventually exceed these levels. The two fisheries are those of Lake Tanganyika, where there is a considerable unexploited stock of *Stolothrissa* and *Limnothrissa*, and Lake Kivu, where a new resource has been established following the introduction of *Limnothrissa* into that lake. One further area remains unexploited: that of Mbandaka Floodplains which, by reason of their inaccessibility and extremely low population density, will probably not be exploited for several decades.

5. KEY BIBLIOGRAPHY

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Zaire Basin: Compere & Symoens, 1987

6. WATER BODIES DIRECTORY

Lakes

Albert (= Mobutu)
Boya
Edward (= Idi Amin)
Kafakumba
Kasuku
Katania
Kivu
Libanda
Lualaba Floodplain/Lakes Complex
(= Kamolondo Depression)
Maji Ndombe
Pool Malebo (= Stanley Pool)
Mukamba
Mweru
Tanganyika
Tumba
Upemba

Flooded forests

in Central Zaire Basin
in Mbandaka area

Rivers

Aruwimi/Ituri
Itimbiri
Kasai/Kwa
Lomani
Lualaba
Luapula
Lulonga
Mongala
Ruki
Ruzizi
Semliki
Ubangi/Oubangui
Zaire/Congo

Reservoirs

Mwadingusha (= Tshangalele; = Lufira)
Nzilo I (= Delcommune)
Nzilo II (= Marinel)

LAKE ALBERT (= MOBUTU)

(International water)

Geographical data (see Fig. 2)
Location: Uganda, Zaire - 1° 9'-2° 17'N; 30° 25'-31° 25'E
Altitude: 618 m
Surface area: Uganda, 2 850 km^2 (54%); Zaire, 2 420 km^2 (46%)
Total: 5 270 km^2
Depth: 58 m (max); 25 m (mean)
Volume: 140 km^3 total; 60 km^3 in Zaire
Max. length: 160 km
Max. width: 35 km
Major inflowing rivers: Semliki, Victoria Nile
Outflowing rivers: Albert Nile (Uganda)

LAKE ALBERT (cont.)

Physical and chemical data (Welcomme, 1972)

Conductivity: K_{20} 675-730 µS/cm

Surface temperature: 26-29° C

Dissolved solids: 565 mg/l (mean);
518-672 mg/l (main lake); 370-680 mg/l (Semliki Delta)

pH: 8.4-9.5

Oxygen: water rich in oxygen at all depths

Ionic composition:

	(Van Der Ben, 1959)	(Talling and Talling, 1965)
	mg/l	mg/l
Na	97.0	91.0
K	66.0	65.0
Ca	9.8	9.8
Mg	31.5	32.1
HCO_3+CO_3	475.8	445.3
Cl	31.0	31.0
SO_4	25.0	32.0
SiO_4	3.4	0.09-0.9
	µg/l	µg/l
NO_3-N	9.0	-
PO_4-P	130.0	-
Total P	-	200.0

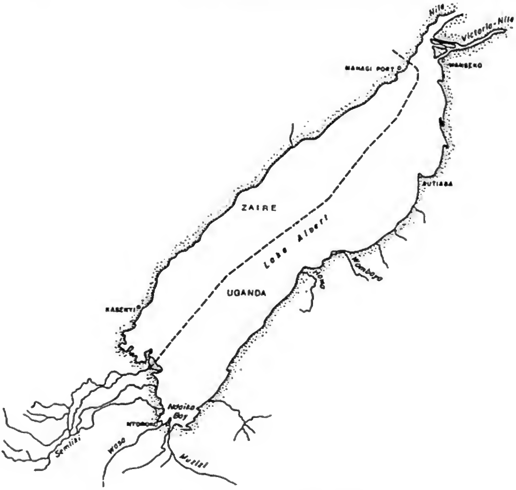

Fig. 2. LAKE ALBERT (MOBUTU)
(after Welcomme, 1972)

LAKE ALBERT (cont.)

Fisheries data
No. of fish species: 46 (Greenwood, 1964)
Main catches: 75-85% of catches are:
Characidae: *Alestes baremose; Hydrocynus forskahli;*
Centropomidae: *Lates niloticus albertianus* (Proude, 1984)
Annual production, entire lake: 15 000 t in 1982 (Giudicelli *et al.*, 1987)
Total annual catch and effort: in Zaire

Year	Total catch (t) **	No.of fishermen	No.of boats
1920	430	-	-
1921-37	-	-	-
1938	2 200	-	-
1939	-	-	-
1940	2 600	-	-
1941-49	-	-	-
1950	1 827*	-	-
1951	2 545*	-	-
1952	3 299*	-	-
1953	4 166*	-	-
1954	6 279*	-	-
1955	7 911*	-	-
1956	9 106*	-	-
1957	11 886*	-	-
1958	9 226*	-	-
1959	10 691	-	-
1960	8 502	-	-
1961	2 749	-	-
1962	1 884	-	-
1963	3 055	-	-
1964	3 360	-	-
1965	3 564	-	-
1966	4 124	-	-
1967	4 276	-	-
1968	4 266	-	-
1969	4 785	-	-
1970	5 500	-	-
1971	7 000	-	-
1972	7 939	-	-
1973	9 000	-	-
1974	5 226	-	-
1975	7 700	18 000	1 860
1976	6 443	-	-
1977	4 412	-	-
1978	9 711	-	-
1979	7 913	-	-
1980	2 988	-	-
1981	5 705	-	-
1982	5 000	11 125	-
1983	3 873	-	2 108

* industrial catches only
** Total catch: industrial + small scale (cited by Proude, 1984)
Note: Due to the variety of sources and methods used, these estimates do not necessarily reflect the actual catches.

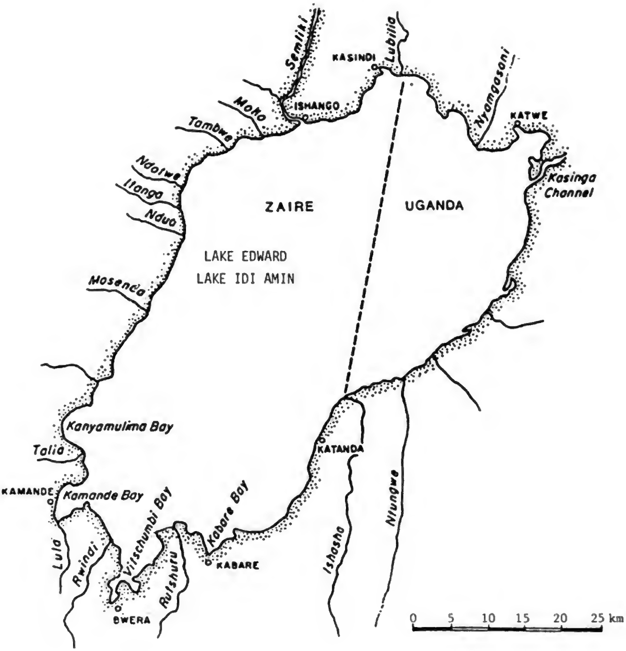

Fig. 3. LAKE EDWARD/IDI AMIN
(after Welcomme, 1972)

LAKE ALBERT (cont.)

Fisheries data (cont.)

Potential annual yield:
Proude (1984), citing several authors, estimates the mean potential annual yield as follows:
11 500 t - Zaire
13 500 t - Uganda
25 000 t - Total lake
Giudicelli *et al.* (1987) gives the following estimates:
15 640 t - Zaire
34 000 t - Total lake

Key reference for Lake Albert (Mobutu): Proude, 1984

LAKE BOYA

Geographical data

Location: Zaire, 7° 22'S; 25° 39'E
Surface area: 7.9 km^2
Max. length: 4.5 km
Max. width 2.5 km

LAKE EDWARD (= IDI AMIN)

(International water)

Geographical data (see Fig. 3)

Location: Uganda, Zaire - 0° 04'-0° 39'S; 29° 20'-30° E
Altitude: 914 m
Surface area: Uganda: 670 km^2 (29%); Zaire: 1 630 km^2 (71%)
Total: 2 300 km^2
Depth: 117 m (max); 34 m (mean)
Volume: 78.2-90 km^3
Max. length: 90 km
Max. width: 40 km
Major inflowing rivers: Rutshuru (also connected to Lake George by the Kazinga Channel), Rwindi, Luholu, Ishasha
Outflowing river: Semliki

Physical and chemical data (Welcomme, 1972)

Conductivity: K_{20} 900 μs/cm (EAFRO, 1954);
925 μs/cm (Talling & Talling, 1965)
Surface temperature: circa 26° C
Dissolved solids: 521 mg/l
pH: 8.5-9.3
Ionic composition: (Talling & Talling, 1965)

	mg/l
Na	110.0
K	9.0
Ca	12.4
Mg	47.3
HCO_3+CO_3	600.0
Cl	36.0
SO_4	31.0
SiO_2	6.5

LAKE EDWARD (cont.)

Physical and chemical data (cont.)

Ionic composition: (cont.)

	µg/l
NO_3-N	24.0
PO_4-P	18.0
Total P	127.0

Fisheries data

No. of fish species: 53, of which 28 are cichlids (Greenwood, 1964)

Main catches: (Jensen et al., 1983; and Vakily, 1989)

Tilapia	*(Oreochromis niloticus eduardianus)*	60-70%
Bagrus	*(Bagrus docmak)*	10%
Barbus	*(Barbus altianalis eduardianus)*	5%
Protoptere	*(Protopterus aethiopicus aethiopicus)*	10%
Clarias	*(Clarias gariepinus)*	10%

No. of boats: about 700 canoes in Zaire in 1988 (Vakily, 1989)

Total annual catch and effort: in Zaire

Year	Total catch (t)	No.of fishermen	No.of boats
Miscellaneous sources			
1952	2 000	-	-
1953	2 836	-	-
1954	3 241	-	-
1955	3 007	-	-
1956	3 108	-	-
1957	5 715	-	-
1958	4 218	-	-
1959	6 000	-	-
1960	6 500	-	-
1961	5 500	-	-
1962	4 000	-	-
1963	3 700	-	-
1964-66	-	-	-
1967	3 500	-	-
1968	2 440	-	-
1969	2 150	-	-
1970	-	-	-
1971	-	1 000	-
1972-74	-	-	-
1975	2 000	-	-
1976	2 000	8 000	-
1977-78	-	-	-
1979	5 000	-	-
1980	-	-	-
1981	1 731	-	-
1982	3 500	-	-
1983	-	2 298	383

Note: Due to the variety of sources and methods used, these estimates do not necessarily reflect the actual catches.

LAKE EDWARD (cont.)

Fisheries data (cont.)

Total annual catch and effort:

Definite sources (t)

Author	Year	Zaire	Uganda	Total lake
Welcomme, 1972	1969-1970	10 351	5 731	16 082
Welcomme, 1979b	-	5 000	-	-
Giudicelli *et al.*, 1987	1985	-	-	10 400
Vakily, 1989	1988	10 000-11 000	3 000	14 000

Potential annual yield: (t)

Author	Zaire	Uganda	Total Lake
Jensen *et al.*, 1983	15 000-20 000	-	-
Giudicelli *et al.*, 1987	-	-	13 000
Vakily, 1989	-	-	15 000-16 000

Key reference for Lake Edward/Idi Amin: Vakily, 1989

LAKE KAFAKUMBA

Geographical data

Location:	Zaire - 9° 42'S; 23° 51'E
Surface area:	7.5 km^2
Max. length:	5 km
Max. width:	1.5 km

LAKE KASUKU

Geographical data

Location:	Zaire - 3° 15'S; 25° 43'E
Surface area:	21 km^2
Max. length:	15 km
Max. width:	2 km

Major inflowing river: Kasuku

Outflowing river: Kasuku

LAKE KATANIA

Geographical data

Location:	Zaire - 6° 29'S; 25° 32'E
Surface area:	3.7 km^2
Max. length:	3.5 km
Max. width:	1.5 km

LAKE KIVU

(International water)

Geographical data (see Fig. 4)

Location:	Rwanda, Zaire - 1° 30'-2° 30'S; 28° 50'-29° 25'E	
Altitude:	1 463 m	
Surface area:	Zaire:	1 370 km^2 (58%)
	Rwanda	1 000 km^2 (42%)
	Total:	2 370 km^2
Depth:	489 m (max); 240 m (mean)	
Max. length:	102 km	
Max. width:	50 km	

Outflowing river: Ruzizi

LAKE KIVU (cont.)

Physical and chemical data (adapted from Welcomme, 1972)
Surface temperature: 24-26° C, thermocline 20-30 m
Conductivity: K_{20} 1 240 μS/cm (Van Der Ben, 1959);
K_{20} 1 276-1 294 μS/cm (Reusens, 1987)
Dissolved solids: 597-1 020 mg/l
pH: 9.1-9.5 (Van Der Ben, 1959)
8.8 (Reusens, 1987)
Ionic composition:

	(Verbeke, 1957)	(Van Der Ben, 1959)
	mg/l	mg/l
Na	130.0	129.0
K	100.0	85.0
Ca	5-15.0	21.2
Mg	100.0	84.0
HCO_3+CO_3	915.0	1 000.4
Cl	35.0	31.0
SO_4	30.0	15.0
SiO_2	2-13.0	9.0
	μg/l	μg/l
NO_3-N	-	41.0
PO_4-P	-	39.0

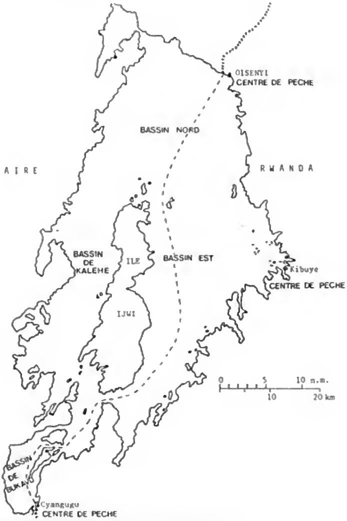

Fig. 4. LAKE KIVU

LAKE KIVU (cont.)

Physical and chemical data (cont.)

Special feature: 50 km^3 methane gas below 200 m depth (Degens *et al.*, 1971)

Oxygen: Surface to thermocline: saturated;
thermocline to -70 m: decreasing;
below 70 m: no oxygen

Photosynthetic production:
1.44 gC/m^2/day (Degens *et al.*, 1971, cited by Beadle, 1981)
(240-540 gC/m^2/year)

Fisheries data

No. of fish species: about 25

Endemic fish species: (Beadle, 1981)

Cyprinidae:	*Barbus spp.*, *Raiamas* (ex *Barilius*) sp.
Clariidae:	*Clarias* sp.
Cichlidae:	*Oreochromis niloticus* *Haplochromis* spp. (6 spp.)

Introduced species:

in 1950:	Cichlidae:	*Tilipia rendalli* *Oreochromis macrochir*
in 1959:	Clupaidae:	*Stolothrissa tanganicae*; *Limnothrissa miodon*

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
in Zaire (miscellaneous sources)			
1952	20	-	-
1957	860	-	-
1958-59	-	-	-
1960	1 200	-	-
1962-73	-	-	-
1974-75	200 b/*	-	-
1976-81	-	-	-
1982	300	-	-
in Lake Kivu			
1950**	303 a/	-	shore fishing
1957**	841 a/	-	shore fishing
1958**	965 a/	-	shore fishing
1986**	723 a/	-	shore fishing
1987*** -*Total*	3 500 b/	1 915	174 (pelagic fishing)
-*in Zaire*	1 925 b/	1 061	
-*in Rwanda*	1 575 b/	854	

a/ Fish: *tilapia* + *Haplochromis*
b/ Fish: *Limnothrissa miodon*

Sources:
* (Aubray, 1976)
** (cited by Hanek *et al.*, 1988)
*** (Hanek *et al.*, 1988)

in Rwanda

Catches obtained by Project "Dèvelop. de la pêche au Lac Kivu" (RWA/87/012):

Year	1979	1980	1981	1982	1983	1984	1985	1986
Total catch: (t)	1	40	70	95	91	200	330	249

In addition, 55 private fishing units are estimated to produce two times more *Limnothrissa miodon* than the Project (Hanek *et al.*, 1988).

Estimated total annual catch in Rwanda (1987): 1 900 t;
(1 575 t *Limnothrissa* + 325 t *tilapia/Haplochromis*)

LAKE KIVU (cont.)

Fisheries data (cont.)

LIMNOTHRISSA MIODON FISHERIES SITUATION
in 1987 *(Reusens, 1987)* and in 1989 *(Johannesson & Lamboeuf, 1989)*

	Zaire	Rwanda	Total
No. fishermen (1987)	1 061	854	1 915
No. boats (1987)			
catamarans	4	42	46
trimarans	63	55	118
traditional	10	-	10
Biomass (1989)			
prerecruits: (2-4cm)	458 t	332 t	790 t (26%)
catchable stock (4-12cm)	1 305 t	945 t	2 250 t (74%)
Total	1 763 t	1 276 t	3 039 t (100%)
density: 12-82 kg/ha			
No. of fishes (1989)			
prerecruits (million)	746	540	1 286 (66%)
catchable stock (million)	385	278	663 (34%)
Total (million)	1 131	818	1 949 (100%)

Potential annual yield:

- Estimation based on Morpho-Edaphic Index (MEI): (Reyntjens, 1982)
MEI, Lake Kivu: 18.29:

Zaire	7 620 t
Rwanda	5 580 t
Total	13 200 t

- Estimation based on zooplankton biomass: (Reyntjens, 1982)
Potential annual yield: 55 kg/ha:

Zaire	7 500 t
Rwanda	5 500 t
Total	13 000 t

- Estimation based on primary productivity:

	(Melack, 1976)	(Oglesby, 1977)
Zaire	40 200 t	1 800 t
Rwanda	26 800 t	1 200 t
Total	67 000 t	3 000 t

- Estimation based on acoustic stock assessment surveys:
(Johannesson & Lamboeuf, 1989)
Biomass catchable stock in 1989:

Zaire	1 305 t
Rwanda	945 t
Total	2 250 t

This estimation must be considered as the most reliable.

Key reference for Lake Kivu: Hanek *et al.*, 1988

LAKE LIBANDA

Geographical data

Location: Zaire - 1° 31'S; 18° 50'E
Surface area: 7.9 km^2
Max. length: 4.5 km
Max. width 2.5 km

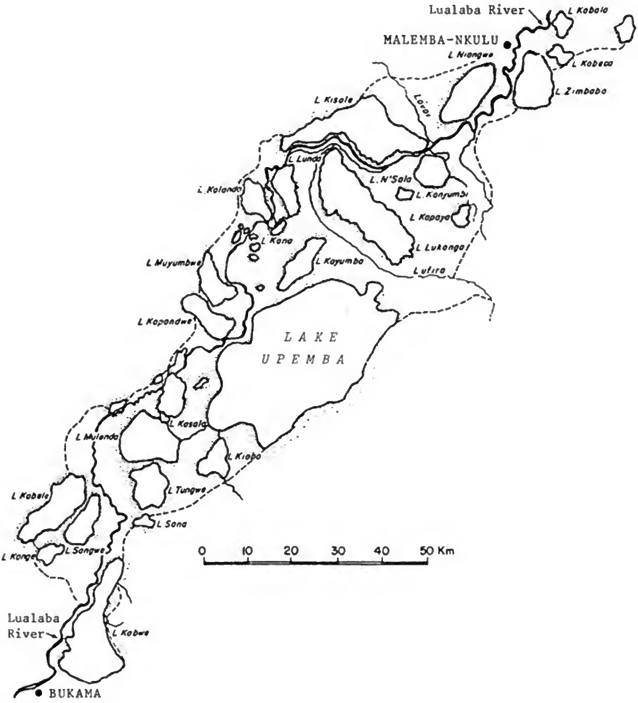

Fig. 5. LAKES OF THE KAMOLONDO DEPRESSION
(Welcomme, 1972)

LUALABA FLOODPLAIN/LAKES COMPLEX (= KAMOLONDO DEPRESSION)

Geographical data (see Fig. 5)

Location: Zaire - 7° 45'-9° 15'S; 25° 50'-27° 15'E

Altitude: 575 m

Surface area: 11 840 km^2 (max flooded area);
7 040 km^2 (low water area, of which
1 545 km^2 consists of permanent lakes and
4 800 km^2 of swamps)

(Konare, 1984):
4 390 km^2 Bukama area
1 866 km^2 Malemba N'Kulu area
6 256 km^2 Total

Max. length: 200-250 km

Major inflowing river: Lualaba

Outflowing river: Lualaba

Special features: The Lualaba River floods an extensive plain of 250 km in length and 40 km in width. More than 50 lakes are found in this area, the most important of which are: Lakes Kabala, Kabele, Kabwe, Kalando, Kange, Kapondwe, Kasala, Kayumba, Kisale, Kiobo, Lukanga, Lunda, Mulenda, Muyumbwe, N'Sala, Sana, Sangwe, Tungwe, Upemba and Zimbabo. Of these, the largest is Lake Upemba (530 km^2) (see separate entry for Lake Upemba). (Welcomme, 1972)

Fisheries data

No. of fish species: 37 species in 16 families (Konare, 1984)

Main catches: *Mormyrus*, *Hydrocynus*, *Alestes*, *Distichodus*, *Clarias*, *Synodontis*, *Lates niloticus*, tilapia (Konare, 1984)

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats	Source
1955	22 000 *	-	-	Compere & Symoens, 1987
1959	16 500 *	-	-	Compere & Symoens, 1987
1975	10 440 **	-	-	Luvuande & Wosey, 1983
1976	11 484 **	-	-	" " "
1977	10 920 **	-	-	" " "
1978	11 233 **	-	-	" " "
1979	11 922 **	-	-	" " "
1980	10 628 **	-	-	-
1981	10 283 **	-	-	-
1982	10 000 **	-	-	-
1983	16 000 *	-	-	Konare, 1984
1984	-	7 668 *	8 559 *	Konare, 1984

* including Lake Upemba
** excluding Lake Upemba

Potential annual yield: 30 000 t (including Lake Upemba) (Konare, 1984)
Productivity: 50 kg/ha/yr

LAKE MAJI NDOMBE

Geographical data (see Fig. 6a) (Welcomme, 1972; Compere & Symoens, 1987)

Location:	Zaire - 2° S; 18° 20'E
Altitude:	340 m
Surface area:	2 300 km^2
Depth:	5 m (mean)
Major inflowing rivers:	Bowele, Lokoro, Lotoi, Olango-Lule, Olango-Nsongo
Outflowing river:	Fimi, into Kwa and Congo/Zaire
Catchment area:	67 680 km^2
Volume:	7.10^9 m^3 (mean); 4.10^9 m^3 (min); 10.10^9 m^3 (max)

Physical and chemical data

pH:	4.2 to 5.5 (Corsi, 1984a)
Oxygen:	present from surface to bottom

Fisheries data

No. of fishermen:	4 600 (1982)
Total annual catch:	1 094 t (Welcomme, 1972) 225 t in 1957 1 500 t in 1982 (includes Lake Tumba)
Potential annual yield:	10 000 t (Welcomme, 1972) 5 750 t (25 kg/ha/yr: Corsi, 1984a) (Lake Maji Ndombe)

Key reference for Lake Maji Ndombe: Corsi, 1984a; Compere & Symoens, 1987.

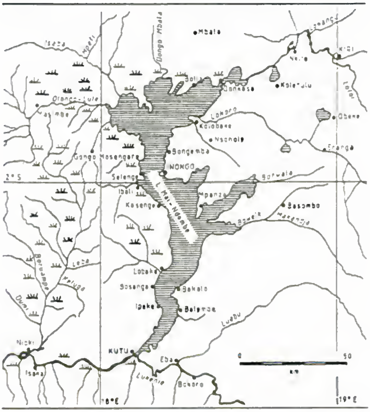

Fig. 6a. LAKE MAI-NDOMBE
(Compere & Symoens, 1987)

POOL MALEBO(= STANLEY POOL)

(International water)

Geographical data (see Fig. 6b) (Welcomme, 1972; Compere & Symoens, 1987)

Location:	Zaire - 4° 15'S; 15° 28'E
Altitude:	272 m
Surface area:	Congo: 330 km^2; Zaire: 220 km^2; Total: 550 km^2
Depth:	20 m (max); 3 m (mean)
Max. length:	40 km
Max. width:	20 km
Shoreline:	95 km
Catchment area:	3 747 320 km^2
Flow:	39 500 m^3/s (mean); 22 000 m^3/s (min); 75 000 m^3/s (max)

Annual fluctuation in level: 3 m (mean)

Major inflowing and outflowing river: Congo/Zaire

Special features: Pool Malebo is a riverine lake, with a large central island (Ile Mbamu, 180 km^2) and several smaller ones (sandbanks) which are subject to inundation.

Physical and chemical data (Compere & Symoens, 1987)

Surface temperature: 27.3° C

pH: 6-7

Conductivity: K: 31.5 µs/cm

Ionic composition: (mean from December 1976 to November 1977)

	mg/l		mg/l
Ca	2.23	HCO_3	7.11
Mg	0.86	SO_4	2
Na	1.99	Cl	2.71
K	1.33	SiO_2	9.7

Fisheries data

No. of fish species: 165 (Poll, 1939); 235 (Compere & Symoens, 1987)

No. of fishermen: 5 000 in Zaire (1984) (Corsi, 1984b)

Total annual catch: 3 000-3 500 t in Zaire (Corsi, 1984b)

Key reference: Compere & Symoens, 1987

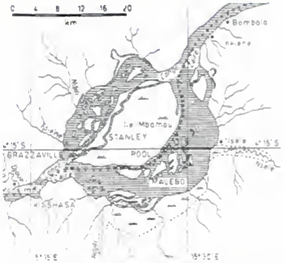

Fig. 6b. Pool Malebo
(Compere & Symoens, 1987)

LAKE MUKAMBA

Geographical data
Location: Zaire - 5° 45'S; 23° 04'E
Surface area: 4.7 km^2
Max. length: 4.5 km
Max. width: 1.5 km

LAKE MWERU
(International water)

Geographical data (see Fig. 7)
Location: Zaire, Zambia - 8° 28'-9° 31'S; 28° 20'-29° 10'E
Altitude: 930 m
Surface area: Zaire 1 950 km^2 (42%)
Zambia 2 700 km^2 (58%)
Total 4 650 km^2 (Konare, 1984)
Depth: 37 m (max); 10 m (mean; N. basin); 3 m (mean: S. basin)
Volume: 38 km^3 (15 km^3 in Zaire)
Max. length: 124 km
Max. width: 51 km
Shoreline: 350 km (140 km in Zaire)
Annual fluctuation in level: 5 m (max); 1.5 m (mean)
Major inflowing rivers: Luapula, Kalungwishi
Outflowing river: Luvua into Lualaba
Special features: the inflowing Luapula River is flanked from both sides of its course between the Johnson Falls at its point of discharge into Lake Mweru by an extensive floodplain (the Luapula Floodplain), covering 1 500 to 2 400 km^2 with scattered permanent lagoons. This area is known as the Kifakula Depression.

Physical and chemical data:
Surface temperature: 19-30° C
Conductivity: K_{20} 70-125 μS/cm (De Kimpe, 1960)
Dissolved solids: 76 mg/l (Stappers, 1914)
pH: 6.4-9.3 (De Kimpe, 1960)
8.5 (Konare, 1984)
Oxygen: 5.4-8.9 mg/l; 70-120% saturation (Compere & Symoens, 1987)
Ionic composition:

	(Stappers, 1914)	(Talling & Talling, 1965)
	mg/l	mg/l
Na	-	4.06
K	-	1.25
Ca	13.07	7.05
Mg	6.0	5.01
HCO_3+CO_3	48.08	48.08
Cl	19.08	5.0
SO_4	-	3.07
SiO_2	1.03	10.05

Fisheries data
No. of fish species: over 100 species; among them, 27 are of fishing interest, *mainly:* *Oreochromis macrochir* (80%); *Clarias sp; Synodontis sp.*, *Barbus altivelis*, Mormyridae (Konare, 1984).

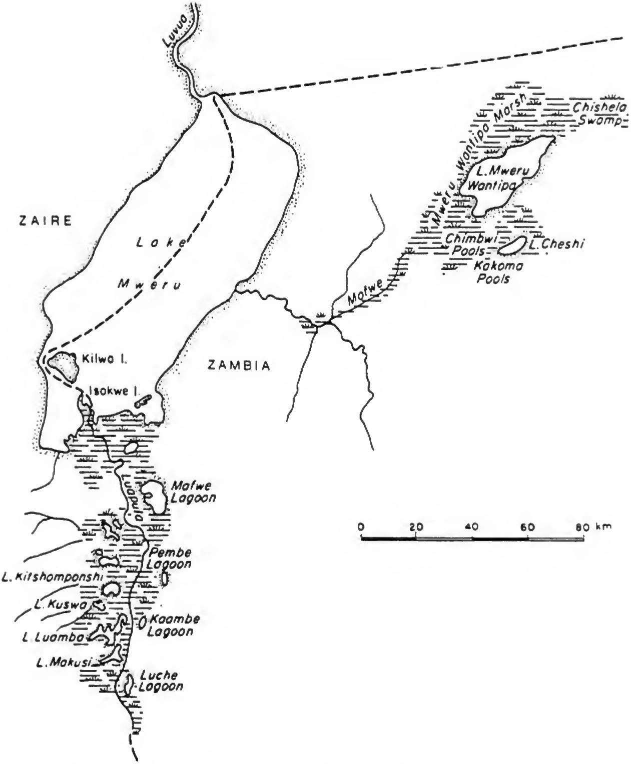

Fig. 7. LAKE MWERU, THE KIFAKULA DEPRESSION, LAKE MWERU WA NTIPA, AND LUAPULA SWAMPS
(Welcomme, 1972)

LAKE MWERU (cont.)

Fisheries data (cont.)
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats	Source
1932	706 *	-	-	FAO, 1983
1933-46	-	-	-	-
1947	4 000 *	-	-	FAO, 1983
1948-51	-	-	-	-
1952	9 400 *	-	-	-
1953-56	-	-	-	-
1957	14 094 *	-	-	-
1958	13 600 *	-	-	FAO, 1983
1959	-	-	-	-
1960	14 000 *	-	-	-
1961-74	-	-	-	-
1975	3 000	2 000	1 500	Aubray, 1976
1976	3 443 *	-	-	Luvuande & Wosey, 1983**
1977	3 274 *	-	-	" " "
1978	3 368 *	-	-	" " "
1979	3 574 *	-	-	" " "
1980	3 186 *	-	-	" " "
1981	3 083 *	-	-	" " "
1982	3 000 *	-	-	-
1983	5 953	1 167	334	Konare, 1984
1983	6 600-8 700	-	-	FAO, 1983

* includes Luapula Swamps
** cited by Compere & Symoens, 1987.

Potential annual yield: 12 000 t Zaire
16 000 t Zambia
28 000 t Total (Konare, 1984)
cited by Compere & Symoens, 1987:
35 000 to 52 000 t/yr for entire Luapula-Mweru system
Productivity: 60 kg/ha (cited by FAO, 1983c)
50 kg/ha (De Kimpe, 1960)

Main reference: De Kimpe, 1964

LAKE TANGANYIKA

(International water)

Geographical data (see Fig. 8)
Location: Burundi, Tanzania, Zaire, Zambia - 3° 20'-8° 50'S; 30° E;
Altitude: 773 m

Surface area:

Burundi	2 600 km^2	(8%)
Tanzania	13 500 km^2	(41%)
Zaire	14 800 km^2	(45%)
Zambia	2 000 km^2	(6%)
Total	32 900 km^2	

Depth: 1 435 m (max); 700 m (mean)
Volume: 18 940 km^3 (9 000 km^3 in Zaire)
Max. length: 673 km
Max. width: 48 km
Shoreline: 1 500 km total; 675 km in Zaire
Catchment area: 249 000 km^2
Major inflowing river: Malagarasi, Ruzizi
Outflowing river: Lukuga

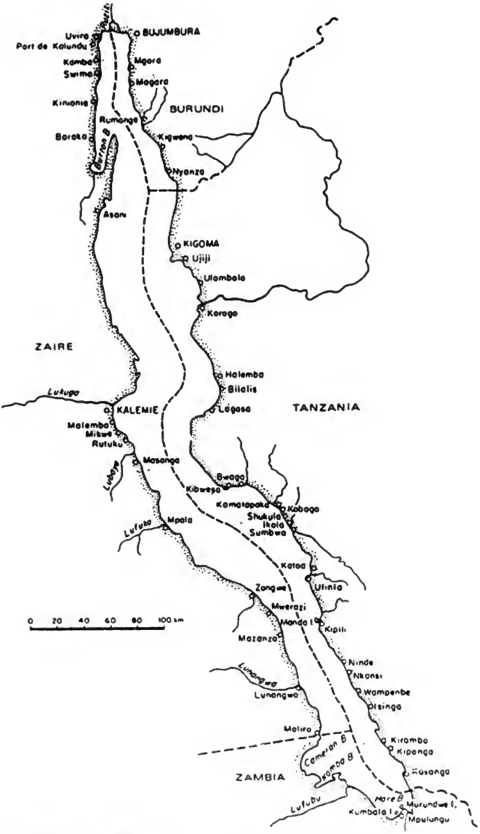

Fig. 8. LAKE TANGANYIKA
(Welcomme, 1972)

LAKE TANGANYIKA (cont.)

Physical and chemical data

Conductivity: K_{20} 520-610 μS/cm

pH: 7.3-7.8

Surface temperature: 25° C

Oxygen limit: 80 m - N. Basin; 150 m - S. Basin (Aubray, 1972)

Photosynthetic production: 0.8-1.1 gC/m^2 day (Melack, 1976)

Ionic composition: (Talling & Talling, 1965)

	mg/l
Na	57.0
K	35.0
Ca	9.3
Mg	43.3
Cl	26.5
SO_4	5.0
SiO_2	0.38
HCO_3+CO_3	409.3

Fisheries data

No. of fish species: 214, of which 134 belong to the Cichlidae family (Greenwood, 1964)

Main catches: (Aubray, 1976)

Clupeidae: *Stolothrissa tanganicae* (75%); *Limnothrissa miodon* (10%)

Centropomidae (15%): *Lates spp.* (3 species); *Luciolates stappersi*

No. of fishermen: in Zaire in 1988: est. 13 000 (Mikkola & Lindquist, 1989)

No. of boats: (Mikkola & Lindquist, 1989)

industrial fishing units (purse seiners): 16

artisanal fishing units (lift nets, etc.): 450

coastal canoe fishing units: 4 000

Total annual catch and effort:

in Lake:

	1982*	1988**
Burundi	13 600	16 000
Tanzania	25 000	25 000
Zaire	30 000	30 000
Zambia	10 500	14 000
Total	80 000	85 000

* (Corsi *et al.*, 1986)

** (Mikkola & Lindquist, 1989)

in Zaire:

Year	Total catch (t)	No.of fishermen	No.of boats	Source
1948	3-4 000	-	-	
1949-56	-	-	-	
1957	29 501	-	-	
1958-59	-	-	-	
1960	35 000	-	-	
1961-69	-	-	-	
1970	7 720	-	-	
1975	17 000	10 000	4 215	Aubray, 1972
1980	15 515	-	-	
1981	13 377	-	-	
1982	17 336	-	4 000	
1983	16 000-19 000	-	-	Jensen *et al.*, 1983
1988	30 000	13 000	4 466	Mikkola & Lindquist, 1989

LAKE TANGANYIKA (cont.)

Fisheries data (cont.)

Potential annual yield:

	(Corsi *et al.*, 1986)	(Mikkola & Lindquist, 1989)
	(t)	(max. t)
Burundi	21 000	23 000
Tanzania	122 000	121 000
Zaire	135 000	133 000
Zambia	19 000	18 000
Total	300 000 (90 kg/ha)	295 000
	(Coulter, 1981)	
	116-140 kg/ha	
Zaire	171 000 to 207 000 t	
Total lake	380 000 to 460 000 t	

LAKE TUMBA

Geographical data (see Figs. 6, 9 and 10)

Location: Zaire - 1° S; 18° E

Altitude: 350 m

Surface area: 765 km^2 (variable) (Marlier, 1958); Basin: ± 7 380 km^2

Depth: 3-5 m (max); 2.4 m (mean)

Max. length: 40 km

Annual fluctuation in level: 3 m, max. level in November-December and May-June; min. level February-March and July-August (Matthes, 1964)

Major inflowing rivers: Nganga, Lobambo, Butuka, Lolo, Modala, Membe and drainage from the flooded forests

In/outflowing river: communicates with the Zaire River through the Irebu channel; in or outflowing, depending on relative water levels of Zaire River and Lake.

Physical and chemical data:

(Brown humic water type; see also entry "Flooded forests in Mbandaba area")

Surface temperature: 27.7-32.9° C

Conductivity: K_{20} 24-32 μS/cm (Dubois, 1959)

Dissolved solids: 72-90 mg/l

pH: 4.5-4.9; 4.2-5.5 (Corsi, 1984a)

Oxygen: present from bottom to surface, but never saturated; 4-6 mg/l (50-70% saturation) (Dubois, 1959)

Fisheries data

No. of fish species: 114 (Matthes, 1964)

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats	Source
1957	400	-	-	
1959	600	-	-	Matthes, 1964
1982	1 500*	700 (Bikoro)	-	Corsi, 1984a

* includes Lake Maji Ndombe

Potential annual yield:

3 500 t (Welcomme, 1972)
2 000 t (28.6 kg/ha) (Matthes, 1964)
1 912 t (25 kg/ha) (Corsi, 1984a)

Key reference for Lake Tumba: Matthes, 1964

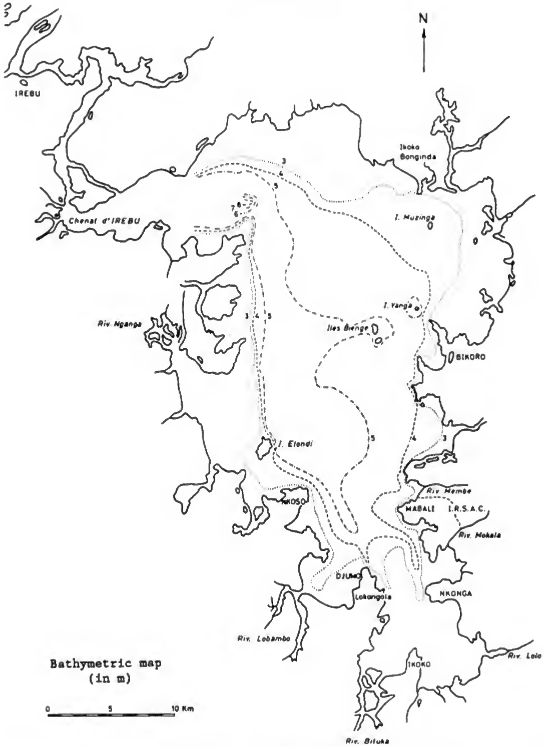

Fig. 9 LAKE TUMBA
(Matthes, 1964)

LAKE UPEMBA

Geographical data (see Fig. 5)
Location: Zaire - 8° 40'S; 26° 20'E
situated in the Lualaba Floodplain/Lakes Complex
(= Kamolondo Depression)
Altitude: 575 m
Surface area: 530 km^2
Volume: 0.9 km^3
Depth: 3.5 m (max); 1.7 m (mean)
Max. length: 40 km
Max. width: 20 km
Major inflowing rivers: Lualaba, Lufira
Outflowing river: Lualaba

Physical and chemical data (after Van Meel, 1953)
Surface temperature: 23.5-33.0° C
Conductivity: K_{20} 145-255 μS/cm
pH: 6.4-8.0
Ionic composition:

	mg/l
Ca	20.6-42.3
Mg	2.9-17.3
HCO_3+CO_3	109.8-203.1
SiO_2	68.0-144.0
	μg/l
PO_4-P	31.0- 65.0

Fisheries data
Total annual catch: (Luvuande & Wosey, 1983)

Year	Total catch (t)
1975	5 220
1976	5 742
1977	5 460
1978	5 517
1979	5 960
1980	5 314
1981	5 141

Potential annual yield: 2 650 t (50 kg/ha: Konare, 1984)

FLOODED FORESTS IN CENTRAL ZAIRE BASIN

Geographical data (see Fig. 10)
Location: Zaire - 3° S-3° N; 16° -21° E
Altitude: 330 m at Equator
Surface area of flooded forests in Zaire:
(see Table 3)
Special features: see "Flooded forests in Mbandaka area" entry.

Physical and chemical data of brown humic waters:
see "Flooded forests in Mbandaka area" entry

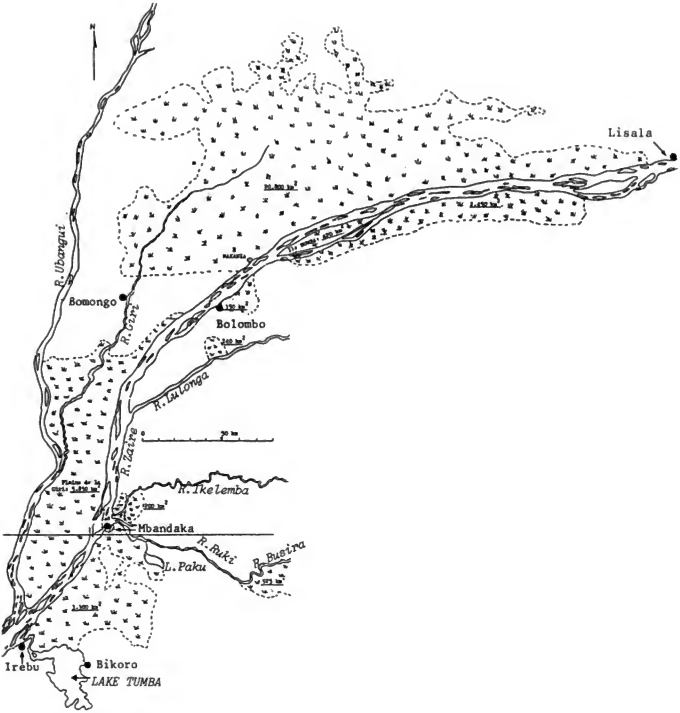

Fig. 10. FLOODED FORESTS IN CENTRAL ZAIRE BASIN FROM LAKE TUMBA TO LISALA
(Vanden Bossche, 1986)

FLOODED FORESTS IN CENTRAL ZAIRE BASIN (cont.)

Table 3. SURFACE AREA OF FLOODED FORESTS IN ZAIRE

	Permanent flood 1/	Seasonal flood (rainy season)
Mbandaka flooded forests 2/	(km^2)	(km^2)
Giri plain	5 850	
Mbandaka/Lake Tumba	3 300	
Lulonga River	140	
Ikelemba River	200	
Busira River	925	
Total	10 415	
Lake Maji Ndombe flooded forests		
West of lake	2 000	19 000 3/
Yumbi	900	
Lotoi River, Lokoro River	535	3 800 3/
Total	3 435	22 800
Makanga-Lisala flooded forests 2/		
right bank	20 800	
left bank	2 450	
Sumba Island	420	
Bolombo	350	
Total	24 020	
Total flooded forests 1/	37 870	

1/ Surface area estimated from Operational Navigation Chart, scale 1:1 000 000 (USAF, 1975)

2/ Vanden Bossche, 1986

3/ Corsi, 1984a

Fisheries data: see "Flooded forests in Mbandaka area" entry

Potential annual yield: (t/yr)

Table 4. POTENTIAL ANNUAL YIELD OF FLOODED FORESTS IN ZAIRE (CENTRAL BASIN)

Flooded forests	Area km^2 1/	15 kg/ha 2/	25 kg/ha 3/
Mbandaka	10 415	15 623	26 038
Lake Maji Ndombe	3 435	5 152	8 587
Makanga-Lisala	24 020	36 030	60 050
Total	37 870	56 805	94 675

1/ permanent flood (ONC-USAF, 1975)

2/ Welcomme, 1989, pers.comm.: 15 kg/ha in brown acid waters

3/ Corsi, 1984a: 25 kg/ha in brown acid waters.

Vanden Bossche (1986) estimates the exploitable potential annual yield of the area from Lake Tumba to Lisala (including Lake Tumba, Zaire River, Mbandaka and Makanga-Lisala flooded forests) at 100 000 to 120 000 t.

FLOODED FORESTS IN MBANDAKA AREA

Geographical data (see Fig. 10)

Location: Central Zaire Basin - 1° S-1° N; 17° 45'-18° 20'E

Altitude: 330 m

Surface area of flooded forests from Makanza to Irebu: (Vanden Bossche, 1986)

	(km^2)
Lulonga	140
Giri plain, Zaire-Ubangi	5 850
Ikelemba	200
Busira (upstream Ruki)	925
Mbandaka-Irebu-Lake Tumba	3 300
Total	10 415

Special features: most of these areas are covered with permanent flooded (hydromorphic) forest. Main water level raisings occur on the bimodal type as Zaire River, although violent floods may occur any time of the year during heavy rains (Vanden Bossche, 1986). The typical "brown waters" occur in the flooded forest, where they are generated, in the medium-sized rivers (Ikelemba, Ruki, Lulonga, Giri), and in the shore-waters of the Zaire River, where they are discharged.

Fluctuation in level in large flood forests:

Giri and Mbandaka, Lake Tumba: 1-3 m;
the water being kept in the forest, the seasonal level fluctuation is lower than in the main river (Vanden Bossche, 1986).

Physical and chemical data of brown humic waters:

(after Berg, 1961; and Berg, cited by Gosse, 1963)
The solubilization of the humic acid materials, produced by plant fragments in anaerobic and reducing conditions, gives the waters of the swamps a low pH and dark brown color. During neutralization in larger rivers, pH, oxygen content, turbidity and conductivity increase, while the brown colour reduces.

Temperature: Forest channels and pools: 20-25° C
Larger rivers and Zaire River: 25-29° C

Other characteristics:

Table 5. PHYSICAL AND CHEMICAL CHARACTERISTICS: RIVERS CENTRAL ZAIRE BASIN (brown humic waters) (Berg, 1961) (cited in Compere & Symoens, 1987)

	Ikelemba	Ruki	Zaire River at Mbandaka
Transparency (m)	1.00	0.85	0.95
Speed (km/h)	3	2	3
Temperature (°C)	25.1	27.5	27.0
pH	3.9	4.2	3.9
Oxygen (mg/l)	2.3	4.8	4.4
(saturation %)	27	58	52
Acidity (ml) Na_2, CO_3, N/1	1.20	0.90	1.40
Alkalinity (ml) H_2SO_4, N/1	0.00	0.00	0.00
Conductivity (µS/cm)	45	24	50

FLOODED FORESTS IN MBANDAKA AREA (cont.)

Table 6. PHYSICO-CHEMICAL CHARACTERISTICS: FOREST CHANNELS, CENTRAL ZAIRE BASIN

	Min.	Mean	Max.
Temperature °C (surface, a.m.)	21.5	23.3	24.7
pH	8.50	4.10	6.20
Conductivity (K_{21} μS/cm)	10.1	22.1	48.9
Acidity (m c/l)	0.26	0.87	1.73
Oxygen (mg O_2/l)	13.2	56.4	86.8
O_2 (mg/l)	0.3	2.3	3.8
SiO_2 (mg/l)	1.0	5.5	8.6
Fe total (mg/l)	0.35	0.75	1.40
NH_3 (mg N/l)	0.15	0.25	0.72
NO_3 (mg N/l)	0.03	0.11	0.30
Ca+Mg (mg Ca/l)	0.1	0.5	1.1
Na (mg/l)	0.20	0.40	0.70
K (mg/l)	0.4	1.1	2.5
Cl (mg/l)	0.2	0.7	1.0

Fisheries data

No. of fish species: Among the 408 sp. cited by Gosse, (1963) (see Zaire River entry), some do not enter in brown waters; others are endemic and/or specialized to brown waters.

Specialized families: Protopteridae, Polypteridae, Notopteridae, Clariidae, Anabantidae, Channidae.

Main fish species in brown waters:
(see Table 7 on following page)

Main catches from brown waters, Mbandaka area: (after Vanden Bossche, 1986)

		% of total catch
Good fishing season:	Channidae	23%
	Clariidae	16%
	Cichlidae	8%
Poor fishing season:	Clariidae	20%
	Protopteridae	14%
	Channidae	10%
	Mormyridae	7%

Annual catch and effort:
2 880 t (=0.9 t/fisherman) in 1986, in Ruki River, Ikelemba River and tributaries, Mbandaka area (Vanden Bossche, 1986)

Potential annual yield of flooded forests: (t/yr)

	Area km^2	15 kg/ha*	25 kg/ha**
Busira	925	1 387	2 312
Lake Tumba-Mbandaka	3 300	4 950	8 250
Ikelemba	200	300	500
Giri plain	5 850	8 775	14 625
Lulonga	140	210	350
Total		15 622	26 037

* Welcomme, 1980, pers.comm.: 15 kg/ha in brown/acid waters
** Corsi, 1984a: 25 kg/ha in brown/acid waters

FLOODED FORESTS IN MBANDAKA AREA (cont.)

Table 7. MAIN FISH SPECIES IN BROWN HUMIC WATERS
(Ikelemba River, Ruki River, flooded forest between Mbandaka and Lake Tumba)
(Vanden Bossche, 1986)

Families	Rivers	Forests	Swamps
Protopteridae	-	-	Protopterus dolloi
Polypteridae	-	-	Polypterus sp.
Clupeidae	-	-	-
Osteoglossidae	-	-	-
Notopteridae	Papyrocranus afer	Papyrocranus afer	Papyrocranus afer
	Xenomystus nigri	Xenomystus nigri	Xenomystus nigri
Mormyridae	Gnathonemus sp.	Gnathonemus sp.	Gnathonemus sp.
	Marcusenius sp.	-	-
	Petrocephalus sp.	Petrocephalus sp.	Petrocephalus sp.
	-	Stomatorhinus sp.	Stomatorhinus sp.
Phractolaemidae	-	-	Phractolaemus ansorgii
Hepsetidae	Hepsetus odoe	Hepsetus odoe	-
Characidae	Alestes sp.	Alestes sp.	-
	Bathyaethiops sp.	-	-
	Bryconaethiops sp.	Bryconaethiops sp.	-
	Alestopetersius sp.	-	-
	Hydrocynus vittatus	-	-
Distichodontidae	Distichodus sp.	-	-
	Xenocharax sp.	-	-
Citharinidae	Citharinus gibbosus	-	-
Cyprinidae	Barbus sp.	Barbus sp.	Barbus sp.
	Raimas sp.	-	-
Bagridae	Auchenoglanis punctatus	Auchenoglanis punctatus	Auchenoglanis punctatus
Clariidae	Clarias gariepinus	Clarias gariepinus	Clarias gariepinus
	-	Clarias sp.	Clarias sp.
	-	Clariallabes sp.	Clariallabes sp.
	-	Channallabes sp.	Channallabes sp.
Schilbeidae	Schilbe sp.	-	-
Mochokidae	Synodontis sp.	Synodontis sp.	-
Malapteruridae	Malapterurus electricus	Malapterurus electricus	Malapterurus electricus
Centropomidae	-	-	-
Cichlidae	Hemichromis sp.	Hemichromis sp.	Hemichromis sp.
	"tilapia"	"tilapia"	-
Anabantidae	Ctenopoma sp.	Ctenopoma sp.	Ctenopoma sp.
Channidae	Channa obscura	Channa obscura	Channa obscura

ARUWIMI/ITURI RIVER

Geographical data
Source: near Lake Albert in Zaire
Total length: 1 030 km
650 km - Upper course (Ituri)
380 km - Lower course (Aruwimi)
Countries traversed: Zaire
Discharges to: Congo/Zaire River at Basoko

ITIMBIRI RIVER

Geographical data

Source: near Sasi, Zaire

Total length: 535 km
315 km - Upper course (Ribi)
220 km - Lower course (Itimbiri)

Countries traversed: Zaire

Discharges to: Congo/Zaire River at Basoko

KASAI/KWA RIVER

(International water)

Geographical data

Source: near Villa Luso, Angola (Kasai)

Altitude: 1 500 m

Total length: 1 735 km total
(last 85 km, from Kasai-Lukenie/Fimi confluence to Congo/Zaire confluence, called Kwa)

Countries traversed: Angola, Zaire

Major tributaries:

Lubilash/Sankuru	1 150 km
Kwango	750 km
Kwilu	960 km
Lukenie/Fimi	1 060 km

Discharges to: Congo/Zaire River at Kwamouth

Special features: Lake Maji Ndombe discharges into Congo/Zaire through the Fimi and Kwa Rivers. In Angola, one tributary (the Luachino River) is impounded by the small 8-m-high Luachino Dam.

LOMANI RIVER

Geographical data

Source: Congo/Zaire - Zambezi divide

Total length: 1 280 km

Discharges to: Isanga, where it joins the Congo/Zaire.

LUALABA RIVER

Geographical data

Source: near Mwepo

Altitude: 1 540 m

Total length: 1 400 km to Kisangani, where its name changes to Congo/Zaire River. It is the main headwater of the Congo/Zaire.

Major tributaries: Luvua (350 km), Lufira (630 km), Lukuga (310 km), Elila (400 km), Lindi (515 km), Lowa (390 km), Ulindi (450 km)

Discharges to: (becomes) Congo/Zaire River

Special features: Nzilo and Mwadingusha Reservoirs, Lufira swamps and Lualaba Floodplain/Lakes Complex (Kamulondo Depression).

LUAPULA RIVER
(International water)

Geographical data (see Fig. 7)
Source: Lake Bangweulu, Zambia
Altitude: 1 140 m
Surface area: 1 500 km^2 Floodplain (Zaire+Zambia) (Welcomme, 1972)
2 400 km^2 River+Floodplain (Zaire+Zambia) (Konare, 1984)
approximately 50% in Zaire
Total length: 560 km
Countries traversed: Zaire, Zambia
Discharges to: Lake Mweru
Special features: the Luapula flows through an extensive swamp system which occupies the Kifükula Depression. This stretches from Johnson Falls to Lake Mweru, a distance of some 160 km and a width of 5-18 km. The total area of the swamp is 1 500 km^2 during the wet season, when a depth of between 5-10 m is attained. The extent of the flooding varies from year to year. Larger permanent lakes on the floodplain include Lakes Kifikula and Kitshomponshi in Zaire and Lake Mofwe in Zambia.

Physical and chemical data:
Conductivity: 150-180 μS/cm; 24.5 μS/cm (Toews, pers.comm.)
pH: 6.2

Fisheries data
Total annual catch and effort: in Zaire

Year	Total catch (t)	No.of fishermen	No.of boats	Source
1932	706*	-	-	FAO, 1983c
1933-46	-	-	-	-
1847	4 000*	-	-	FAO, 1983c
1948-51	-	-	-	-
1952	9 400*	-	-	-
1953-56	-	-	-	-
1957	14 094*	-	-	-
1958	13 600*	-	-	FAO, 1983c
1959	-	-	-	-
1960	14 000*	-	-	-
1961-81	-	-	-	-
1983	8 804	2 850	2 628	Konare, 1984
1983	2 000-3 000	-	-	FAO, 1983c

* includes Lake Mweru

Potential annual yield:
10 000 t - River+Floodplain, Zaire + Zambia
5 000 t - River+Floodplain, Zaire (Konare, 1984) (FAO, 1983c)

Productivity: 40 kg/ha (cited by FAO, 1983c)

Main Reference: De Kimpe, 1964

LULONGA RIVER

Geographical data (see Fig. 10)
Source: Zaire
Altitude: 457 m
Total length: 705 km total
515 km - Upper course (Maringa tributary)
190 km - Lower course (Lulonga)
Countries traversed: Zaire
Major tributaries: Lopori (470 km) which joins Maringa at Basankusu to form Lulonga
Discharges to: Congo/Zaire River

MONGALA RIVER

Geographical data
Source: near Sogo
Total length: 510 km total
225 km - Upper course (Ebola tributary)
285 km - Lower course (Mongala)
Countries traversed: Zaire
Major tributaries: Dua (225 km) and Likame (130 km), both of which have a common confluence with the Ebola to form the Mongala
Discharges to: Congo/Zaire River

RUKI RIVER

Geographical data (see Fig. 10)
Source: near Katako - Kombe
Total length: 930 km total
650 km - Upper course (Tshuapa tributary)
280 km - Lower course (Ruki)
Countries traversed: Zaire
Major tributaries: Lowela (560 km), which joins Tshuapa to form Ruki; Salonga; Momboyo/Luilaka (535 km)
Discharges to: Congo/Zaire at Eala
Special features: flooded forests in its lower course:
see entry "Flooded Forests in Mbandaka Area"

Physical and chemical data (see Table 5, page 331)

Fisheries data see entry "Flooded Forests in Mbandaka Area"

RUZIZI RIVER
(International water)

Geographical data
Source: Lake Kivu
Total length: about 150 km
Countries traversed: Burundi, Rwanda, Zaire
Discharges to: Lake Tanganyika

Physical and chemical data
Conductivity: Upper course K_{18} 1 190 μS/cm; Lower course K_{18} 828 μS/cm

RUZIZI RIVER (cont.)

Physical and chemical data (cont.)

Ionic composition:

	(Beauchamp, 1939) mg/l	(Dubois, 1958) mg/l
Na	94.8	98.0
K	63.0	74.0
Ca	8.4	8.5
Mg	67.0	101.6
HCO_3+CO_3	638.1	585.6
Cl	23.8	16.6
SO_4	17.8	9.0
SiO_2	9.0-9.8	8.0

SEMLIKI RIVER

(International water)

Geographical data

Source: Zaire, Lake Edward/Idi Amin
Altitude: 619 m
Countries traversed: Uganda, Zaire
Discharges to: Lake Albert/Mobutu

Physical and chemical data

Conductivity: K_{20} 400-910 μS/cm (Beauchamp, 1956)

Ionic composition:

	(EAFRO, 1952b) mg/l	(Van Der Ben, 1959) mg/l
Ca	15.0	-
HCO_3+CO_3	436.8	454.3
Cl	-	30.7
SO_4	-	36.4
SiO_2	24.0	3.8

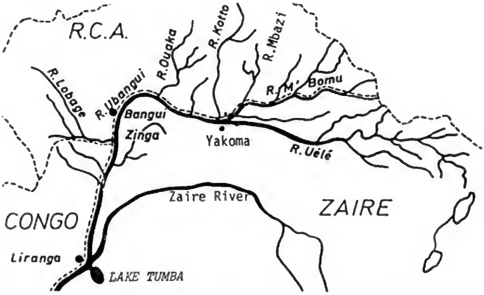

Fig. 11. UBANGI RIVER
(after Micha, 1973)

UBANGI/OUBANGUI RIVER
(International water)

Geographical data (see Figs. 10 and 11)

Source: The Ubangi is formed by the confluence of the Uèlè and M'Bomu Rivers at Yakoma. The Uèlè rises in the mountains near Lake Albert, whereas the Bomu has its source on the frontier between Sudan, Central African Republic and Zaire.

Total length: Mbomou/Bomu: 710 km (Zaire, Central African Republic)
Uèlè: 1 210 km (Zaire)
Ubangi: 1 060 km (Congo, Central African Rep., Zaire)
The longest continuous course (2 270 km) is the Uèlè + Ubangi.

Drainage area: 772 800 km^2

Countries traversed: Congo, Central African Republic, Zaire

Major tributaries: Kotto, Ouaka, Mbori, Lobaye, M'Bomu

Discharges to: Congo/Zaire at Liranga

Flood regime: August to December, max. in October (unimodal)
Low in March-April

Flow at Bangui: 800 to 11 000 m^3/sec; mean: 4 000 m^3/sec

Level variation: 5.5 m (mean); 9 m (max.)

Physical and chemical data

pH: 7.0-7.2 (Depasse, 1956)
6.2-6.9 (Micha, 1973) in Bangui

Conductivity: 19.5-56.0 µS/cm in Bangui (Micha, 1973)

Oxygen: mean at Bangui: 6 mg/l, 75% saturation (Micha, 1973)

Fisheries data

No. of species: 233 in 25 families (Gosse, 1968; Micha, 1973)

Total annual catch:
2 000 t (Ubangi)
3 720 t (Uèlè) year unknown

Potential annual yield:
3 000 t in Zaire (25 kg/ha) (Aubray, 1976)

ZAIRE/CONGO RIVER
(International water)

Geographical data (see Fig. 1)

Source: The longest continuous stream is: Chambezi River, Lake Bangweulu, Luapula River, Lake Mweru, Luvua River, Lualaba River. The Lualaba River changes its name to Congo/Zaire at Kisangani, 2 000 km from the mouth. It is navigable from the mouth to Matadi, and from Kinshasa to Kisangani.

Altitude: The highest source in Zaire is that of the Lualaba: 1 535 m asl. (Aubray, 1976)

Total length: 4 700 km from source Chambezi River in Zambia

Drainage area: 4 014 500 km^2

Area of water: (including Ubangui basin) (Aubray, 1976)

Congo/Zaire	17 000 km^2
Tributaries of Congo/Zaire	4 100 km^2
Ubangi and tributaries	1 300 km^2
Other rivers	8 500 km^2
Kasai and tributaries	3 100 km^2

Countries traversed: The basin covers parts of Angola, Burundi, Cameroon, Central African Republic, Congo, Rwanda, Tanzania, Zaire, Zambia.
The Zaire/Congo River traverses Zambia, Zaire, Congo, Angola.

ZAIRE/CONGO RIVER (cont.)

Geographical data (cont.)

Major tributaries: Alima, Aruwimi, Elila, Itimbiri, Kwa, Lomami, Lowa, Lufira, Lukuga, Lulonga, Luvua, Mongala, Sangha, Ruki, Ubangi/Oubangui.

Discharges to: South Atlantic (6° S; 12° 30'E)

Volume of discharge at mouth: 23-75 000 (mean 41 000) m^3/sec (Aubray, 1976)

Suspended silt load: 50 500 000 t/yr (Welcomme, 1972)

Flood regime: Bimodal floods with peaks in May and December

Special features: Lakes: Tanganyika, Kivu, Bangweulu, Mweru, Maji Ndomba, Pool Malebo, Upemba, Tumba. Waterfalls: Portes d'Enfer, Wagania, numerous cataracts; Dams on nearly all tributaries. Floodplains: Luapula/Kifakula depression, Lualaba/Kamalondo depression, Mbandaka flooded forests.

Physical and chemical data

pH: Both pH and conductivity vary considerably in the different water courses of the system.
pH may be as low as 4.4 in flooded forests when the humic acids are not neutralized, and may be as high as 7.8 (Gosse, 1963) in the Zaire River main stream when the humic acids are neutralized.
5.5 in upper course (Poll & Ranson, 1948);
6.5-7.0 in middle course (Depasse, 1956);
7.05-7.8 Yangambi (middle course), mean 7.4 (Gosse, 1963)

Oxygen: Yangambi: 6.7-8.2; mean: 7.2 mg/l (Gosse, 1963)
Oxygen concentration is low at low pH (4-5),
and higher at higher pH (7-8) (Compere & Symoens, 1987)

Temperature: Yangambi: 27.3° C (Gosse, 1963)

Conductivity:

Yangambi, middle river: K_{21} 37.9-76.7 (mean 56.6) μS/cm
Shore (middle course): K_{21} 37.1-59.0 (mean 47.0) μS/cm (Gosse, 1963)
Luapula (upper course): K_{20} 44-108 μS/cm (Welcomme, 1972)

Table 8. PHYSICO-CHEMICAL CHARACTERISTICS OF RIVERS OF THE CENTRAL ZAIRE BASIN
(Berg, 1961) (cited in Compere & Symoens, 1987)

	Mongala	Ikelamba	Ruki	Zaire at Mbandaka	
				shore	centre
Transparency (m)	1.40	1.00	0.85	0.95	0.70
Speed (km/h)	5	3	2	3	3
Temperature (°C)	25.0	25.1	27.5	27.0	28
pH	5.8	3.9	4.2	3.9	7.4
Oxygen (mg/l)	2.3	2.3	4.8	4.4	6.7
(saturation %)	27	27	58	52	82
Acidity (ml) Na_2, CO_3, N/1	0.55	1.20	0.90	1.40	0.25
Alkalinity (ml) H_2SO_4, N/1	0.08	0.00	0.00	0.00	0.43
Conductivity (μS/cm)	20	45	24	50	56
Type of water *	(b)	(a)	(a)	(a)	(c)

* (a) = humic water
(b) = humic water, partially neutralized
(c) = humic water, completely neutralized

ZAIRE/CONGO RIVER (cont.)

Physical and chemical data (cont.)

Ionic composition:

	(Meybeck, 1978) mg/l	(Gosse, 1963)* mg/l
Ca	2.40	6.4-12.1 (mean: 8.1)
Mg	1.25	
Na	1.70	2.2-4.9 (mean: 3.6)
K	1.10	1.6-2.5 (mean: 1.9)
HCO_3	11.2	-
Cl	2.85	1.5-2.7 (mean: 2.0)
SO_4	2.95	-
SiO_2	9.80	-

* Yangambi, middle Zaire River

Fisheries data

No. of fish species: 408 indigenous fish species in middle Zaire River, distributed in 24 families and 101 genera (Gosse, 1963). (See Table 9.)

Table 9. FISH SPECIES IN MIDDLE ZAIRE RIVER

	Yangambi		Malebo Pool		Central basin	
Families	Species	%	Species	%	Species	%
Protopteridae	2	0.8	2	0.8	2	0.6
Polypteridae	6	2.5	5	2.1	7	1.7
Clupeidae	6	2.5	1	1.7	9	2.2
Mormyridae	43	18.2	46	19.6	75	18.5
Notopteridae	1	0.4	2	0.8	2	0.6
Phractolaemidae	1	0.4	1	0.1	1	0.3
Pantodontidae	1	0.4	1	0.1	1	0.3
Characidae	26	10.5	17	7.2	35	8.4
Citharinidae	27	11.3	23	9.8	38	9.3
Cyprinidae	29	12.1	24	10.2	52	12.8
Clariidae	15	6.3	11	1.7	23	5.7
Schilbeidae	7	2.9	5	2.1	13	3.2
Bagridae	10	4.2	17	7.2	27	6.7
Mochokidae	20	8.4	24	10.2	36	8.9
Amphiliidae	5	2.1	3	1.3	12	3.0
Malapteruridae	1	0.4	1	0.1	1	0.3
Cyprinodontidae	5	2.1	7	3.0	11	2.7
Cichlidae	14	5.9	17	7.2	32	7.6
Centropomidae	1	0.4	1	0.4	1	0.3
Eleotridae	1	0.4	1	3.4	1	0.3
Anabantidae	10	4.2	10	4.3	12	3.0
Ophiocephalidae	1	0.4	1	0.4	2	0.6
Mastacembelidae	5	2.1	8	3.4	11	2.7
Tetraodontidae	2	0.8	4	1.7	4	1.0
Total	239		235		408	

One family (Osteoglossidae) and one species (*Heterotis niloticus*), introduced in Zaire Basin (Ubangi River) in 1960 (Micha, 1973) must be added; *Heterotis niloticus* already commonly caught in Mbandaka area (Vanden Bossche, 1986).

Main fish species in Zaire River, central basin: (Vanden Bossche, 1986) (See Table 10 on following page)

ZAIRE/CONGO RIVER (cont.)

Table 10. MAIN FISH SPECIES IN ZAIRE RIVER, CENTRAL BASIN
(Vanden Bossche, 1986)

Familles	Pelagiques*	Benthiques**	Eaux littorales**
Protopteridae	-	-	Protopterus dolloi
Polypteridae	-	(Polypterus sp.)	Polypterus sp.
Clupeidae	Odaxothrissa sp.	-	Odaxothrissa sp.
Osteoglossidae	-	Heterotis niloticus	Heterotis niloticus
Notopteridae	-	-	Papyrocranus afer
			Xenomystus nigri
Mormyridae	-	Gnathonemus sp.	Gnathonemus sp.
	-	-	Genyomyrus sp.
	-	Mormyrus caballus	Mormyrus caballus
	-	Mormyrus sp.	Mormyrus sp.
	-	Mormyrops deliciousus	Mormyrops deliciousus
	-	Marcusenius sp.	Marcusenius sp.
	-	Petrocephalus sp.	Petrocephalus sp.
Phractolaemidae	-	-	Phractolaemus ansorgii
Hepsetidae	-	-	-
Characidae	Alestes sp.	-	Alestes sp.
	-	-	Bathyaethiops sp.
	Bryconaethiops sp.	-	Bryconaethiops sp.
	Alestopetersius sp.	-	Alestopetersius sp.
	Hydrocynus goliath	-	-
	Hydrocynus vittatus	-	Hydrocynus vittatus
Distichodontidae	-	Distichodus antonii	Distichodus antonii
	-	Distichodus sp.	Distichodus sp.
	Eugnathichthys sp.	-	Eugnathichthys sp.
	-	-	Xenocharax sp.
Citharinidae	Citharinus gibbosus	Citharinus gibbosus	Citharinus gibbosus
Cyprinidae	Barbus cardozoi	Barbus cardozoi	Barbus cardozoi
	-	Barbus sp.	Barbus sp.
	-	Labeo velifer	Labeo velifer
	Raiamas sp.	-	Raiamas sp.
Bagridae	-	Chrysichthys cranchii	Chrysichthys cranchii
	-	Chrysichthys sp.	Chrysichthys sp.
	-	Auchenoglanis occidentalis	Auchenoglanis occidentalis
	-	-	Auchenoglanis punctatus
	-	Gephyroglanis sp.	Gephyroglanis sp.
Clariidae	-	Heterobranchus longif.	Heterobranchus longif.
	-	-	Clarias gariepinus
Schilbeidae	Eutropius sp.	-	Eutropius sp.
	Schilbe sp.	-	Schilbe sp.
Mochokidae	-	Synodontis sp.	Synodontis sp.
Malapteruridae	-	Malapterurus electricus	Malapterurus electricus
Centropomidae	Lates niloticus	Lates niloticus	-
Cichlidae	-	-	Hemichromis sp.
	-	-	"Tilapia"
Anabantidae	-	-	Ctenopoma sp.
Channidae	-	-	Channa obscura

* neutralized waters

** neutralized and partly neutralized waters

ZAIRE/CONGO RIVER (cont.)

Fisheries data (cont.)

No. of fishermen: 40-50 000 in Zaire River (Corsi, 1984b)
Main catches: (See Table 11)

Table 11. RELATIVE PERCENTAGE OF FAMILIES CAUGHT IN MBANDAKA AREA AND SOLD IN MBANDAKA MARKETS
(Vanden Bossche, 1986)

A=during good fishing season (Feb.-March, 1986)
B=during poor fishing season (Nov.-Dec., 1985)

Families	A	B
Protopteridae	1	14*
Polypteridae	<1*	1*
Mormyridae	4.5	7*
Characidae	2.5**	4**
Hepsetidae	1*	<1*
Citharinidae	2	4
Distichodontidae	13**	12**
Cyprinidae	10**	5.5**
Schilbeidae	<1**	<1
Clariidae	16*	20*
Bagridae	12**	10**
Mochokidae	<1	1.5**
Cichlidae	5*	<1*
Clupeidae	-	1**
Notopteridae	<1	<1
Centropomidae	1**	-
Malapteruridae	2**	1
Phractolaemidae	-	<1*
Anabantidae	-	<1*
Channidae	23*	10*
Osteoglossidae	2**	3**
Fingerlings (Miscellaneous)	3.5***	4
Total	100%	100%

* = catches mainly in Zaire River tributaries: Ruki River and adjacent flooded forest channels (humic, acid, brown waters)
** = catches mainly in Zaire River mainstream (neutralized waters)
*** = mainly cichlidae

Fishing seasons: (See Fig. 12 on following page)
Mean annual catch per fisherman: (Corsi, 1984b)
800-1 000 kg - 60 km upstream to 120 km downstream Kisangani
1 300-1 500 kg - 120 km downstream Kisangani to Basoko
2 000-2 200 kg - Basoko to Lulonga
1 500-1 800 kg - Mbandaka area
1 300-1 700 kg - Irebu to Bolobo
600-700 kg - Pool Malebo

Total annual catch: in Zaire (t)

Zaire River	47 500 *
Tributaries of Zaire River	10 200
Ubangi and tributaries	5 720
Kasai and tributaries	2 750
Other rivers	12 750
Total (in 1961)	78 920

* in Zaire River in 1984: 70-75 000 t (Corsi, 1984b)

ZAIRE/CONGO RIVER (cont.)

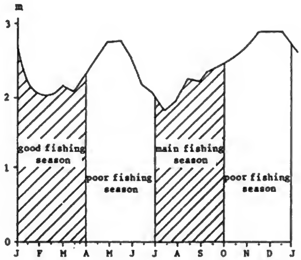

Fig. 12. ZAIRE RIVER: BIMODAL MEAN FLOW AT MBANDAKA (1932-1983)
related to fishing seasons
(after Corsi, 1984)

Fisheries data (cont)

Potential annual yield:
150 000 t in Zaire - Zaire River and its tributaries (smaller rivers, floodplains) (Corsi, 1984b)
50 000 t in Zaire River, itself, excluding tributaries (rough estimate based on several authors)

Main references for fish determination and taxonomy in Zaire:
Gosse, 1968;
Lambert, 1961;
Matthes, 1964;
Poll, 1939, 1957;
Poll & Gosse, 1963

MWADINGUSHA (= TSHANGALELE) (= LUFIRA) RESERVOIR

Geographical data

Location:	Zaire - 10° 54'S; 27° 03'E
Altitude:	1 100 m
Date closed:	1938
Surface area:	446 km^2 (max)
Depth:	14 m (max); 2.6 m (mean)
Max. length:	25 km
Max. width:	24 km
Major inflowing river:	Lufira
Outflowing river:	Lufira
Shoreline:	170 km
Volume:	1.063 km^3
Level variation:	1 to 3 m

MWADINGUSHA RESERVOIR (cont.)

Physical and chemical data:

Surface temperature: 25-26° C in rainy season (Konare, 1984)

Conductivity: K_{20} 128-309 μS/cm

pH: 7.1-8.2; 7.5-8.4 (Konare, 1984)

Oxygen: 15.0 mg/l, Jan.; 2.0, April; 21.0, July (Konare, 1984)

Ionic composition:

	mg/l
Na	3.07-6.0
K	0.78-1.56
Ca	11.04-49.07
Cl	0.71-2.49
SO_4	0.19-5.0
SiO_2	14.06-21.06
NO_3-N	3.01-11.02
PO_4-P	9-18.00

Fisheries data

No. of fish species: 6 families, 17 species, from Lufira River

Main catches: (fishing interest): *Tilapia melanopleura, Oreochromis macrochir, Serranochromis kafuensis, Clarias gariepinus* (Konare, 1984)

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1953	314	-	-
1954	2 354	-	-
1955	7 991	-	-
1956	674	-	-
1957	1 359	-	-
1958	4 223	-	-
1959-60	-	-	-
1961	6 115	-	-
1962-77	-	-	-
1978	1 500	-	-
1979-81	-	-	-
1982	4 350	-	-
1983	3 106*	1 410	1 583 (Konare, 1984)

* 1 606 t marketed fish + 1 500 t fishermen consumption

Potential annual yield: 4 460 t (100 kg/ha) (Konare, 1984)

NZILO (= NZILO I; = DELCOMMUNE) RESERVOIR

Geographical data

Location: Zaire - 10° 40'S; 25° 40'E

Altitude: 1 246.75 m at USL

Surface area: 280 km^2

Depth: 8.3 m (mean) (Konare, 1984)

Volume: 1.733 km^3

Max. length: 35 km

Max. width: 15 km

Annual fluctuation in level: up to 9 m

Major inflowing river: Lualaba

Outflowing river: Lualaba

NZILO RESERVOIR (cont.)

Physical and chemical data

Surface temperature: 25-26° C (rainy season)
5-10° C (dry season - April-July) (Konare, 1984)

Conductivity: K_{20} 400 µS/cm (Welcomme, 1972)

pH: 7.7-8.5

Oxygen: 4.26 to 9.31 mg/l (Konare, 1984)

Fisheries data

Fish species: (fishing interest): (Konare, 1984)
Oreochromis macrochir (main catches); *Labeo* sp.; *Barbus* sp.; *Clarias gariepinus; Tilapia melanopleura; Serranochromis kafuensis.*

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats	Source
1957	2 364	-	-	
1958-59	-	-	-	
1960	3 500	-	-	
1961	2 364	-	-	
1962-80	-	-	-	
1981	333*	-	-	Konare, 1984
1982	150*	-	-	Konare, 1984
1983	120*	-	-	Konare, 1984
1984	-	830	346	Konare, 1984

* based on marketed fish only

Potential annual yield: 2 520 t (90 kg/ha) (Konare, 1984)

NZILO II (= MARINEL) RESERVOIR

Geographical data

Location: Zaire - 10° 40'S; 25° E (immediately downstream from Nzilo I Dam)

Major inflowing river: Lualaba (outflow from Nzilo I dam)
Outflowing river: Lualaba

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ZAMBIA

1. GEOGRAPHY AND CLIMATE

Zambia (with a surface area of 740 720 km^2) is situated on a plateau which varies between 1 000 and 1 500 m in altitude. Land of slightly higher elevation traverses the country from the centre to the northeast and forms the watershed between the Zambezi and Zaire Basins.

The climate is subtropical with pronounced seasons: winter (May to August) and summer (September to March). The main rainfall is concentrated into a single season from October to April.

Zambia is mainly an agricultural country, but with a developed mining industry in the north. There is some pastoralism on the floodplain flats, and three major barrages (Kariba, Kafue Gorge, and Itazhitezhi) have been installed for power generation.

2. HYDROGRAPHY (see Fig. 1)

2.1 Lakes

Zambia has abundant lacustrine resources which include significant portions of Lakes Tanganyika and Mweru as well as Lakes Bangweulu and Mweru Wa Ntipa. Smaller lakes include Ishila Ngandu, Lusiwashi and Ben. There are numerous lakes of varying sizes associated with the major floodplains.

2.3 Rivers, Floodplains and Swamps (mainly Welcomme, 1979a)

Part of two major river basins, the Zambezi and the Zaire, lie within Zambia. In the Zambezi Basin, the Zambezi River itself flows for 600 km through the country and forms the frontier successively with Namibia, Botswana, Zimbabwe and Mozambique for a further 825 km. The main tributaries are the Kafue (855 km) and the Luangwa (780 km).

In the Zaire Basin the Chambezi River (465 km) flows into the Bangweulu swamp/lake complex and the Luapula (555 km) flows out of it into Lake Mweru. The Luapula River forms the frontier with Zaire for much of its length.

Major floodplain/swamp systems associated with the rivers are: Barotse Floodplain (Zambezi River); Lukanga Swamp (Kafue River); Kafue Flats/Gorge Reservoir Complex (Kafue River); Luapula Floodplain (Kifukula Depression) (Luapula River). Two smaller swamps (Kapabi, containing Lake Wasa, and Chibwa) occur on headwater tributaries of the Luapula River. The Busanga Swamp is located on the Lufupa, a tributary of the Kafue.

2.3 Reservoirs

Forty-five percent of Lake Kariba (2 412 km^2) lies within Zambia and two smaller reservoirs (Mulungushi and Mita Hills) are situated near Lusaka. There are large dams across the Kafue River at either end of the Kafue Flats floodplain; Itezhitezhi Dam forms a reservoir of 360 km^2, while Kafue Gorge Dam controls, to some extent, the water level on the Kafue Flats. L'Heureux (1985) reported that there are some 479 major dams.

2.4 Coastal Lagoons: None; Zambia is landlocked.

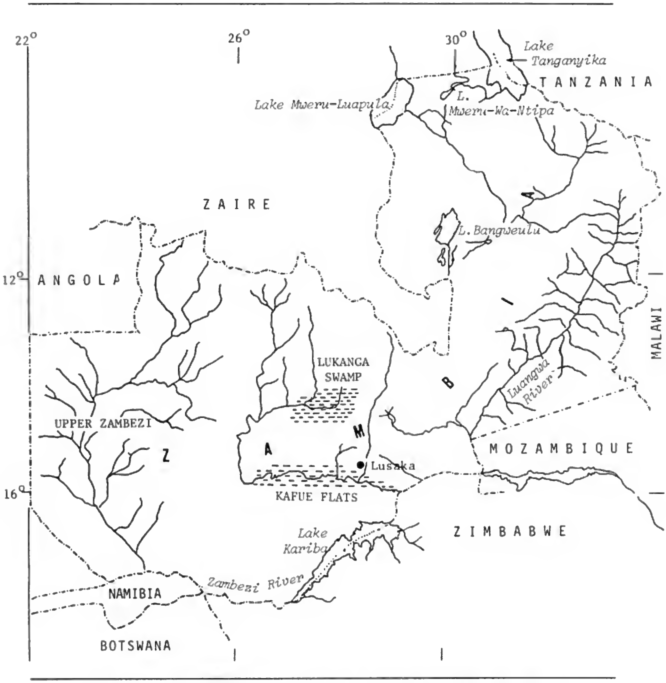

Fig. 1. GEOGRAPHICAL LOCATION OF FISHERIES COVERED BY THE FISHERIES STATISTICAL SURVEY
(Bazigos et al., 1975)

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture

L'Heureux (1985) reported the aquaculture situation as follows:

"The extent of fish-farming in Zambia is not very well known. Most estimates give as 313 ha the total surface under production including 47 ha or 15% in government stations, 180 ha or 58% in commercial farms and the rest (86 ha or 27%) in rural ponds exploited mostly for self-consumption. This area estimate of 313 ha represents a substantial increase from the 1967 estimate of 100 ha.

"There are 19 government stations, with a total of 338 ponds, of 1 400 m^2/pond on average. The number of commercial fish farmers is estimated at 90. Total number of ponds is estimated at 500, with an average of 3 600 m^2/pond (including small reservoirs stocked for fish farming). There would be around 2 000 rural farmers which have included fish farming in their activities; they would exploit 2 162 ponds with an average of 400 m^2/pond.

"Average yield for government stations is estimated at 2 t/ha, which represents a total annual production of 94 tons for that sector. Commercial fish farms are estimated to have average yields of 3 t/ha, which would give a total annual production of 540 tons. Rural ponds have estimated yields of 1 t/ha, for a total production of 86 tons. Thus total fish farming in Zambia would be about 710 tons. Those figures were estimated in collaboration with FAO/UNDP project management. This nevertheless represents a substantial increase from the 1967 level of production estimated at 88.7 tons.

"At its present state of development, fish farming production would represent less than 2% of total fish production in Zambia. But taking into account that output from fish farms is sold fresh, it represents around 5% of that fresh fish supply."

Aquaculture production in 1987 reached 1 020 tons, including 918 tons of *Oreochromis andersonii*, 71 tons of various tilapia species, and 31 tons of *Cyprinus carpio* (Vincke, 1989, pers.comm.).

3.2 Fish production and per caput supply

Table 1. FISH PRODUCTION AND PER CAPUT SUPPLY - Zambia, 1970-1987

		Nominal Domestic Production (excluding exports) (t) 2/			Nominal Consumer Supply (exluding imports and exports (kg/person)		
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Total	Inland capture	Aqua-culture 3/	Total
1970	4 189	48 400	- 4/	48 400	11.5	- 4/	11.5
1971	4 312	39 300	-	39 300	9.1	-	9.1
1972	4 439	34 800	-	34 800	7.8	-	7.8
1973	4 569	50 400	-	50 400	11.0	-	11.0
1974	4 703	46 929	-	46 929	10.0	-	10.0
1975	4 841	57 426	-	57 426	11.8	-	11.8
1976	4 988	54 267	-	54 267	10.9	-	10.9
1977	5 142	53 732	-	53 732	10.4	-	10.4
1978	5 303	47 567	-	47 567	8.9	-	8.9

Table 1. (cont.)

Year	Population '000 1/	Nominal Domestic Production (excluding exports) (t) 2/			Nominal Consumer Supply (exluding imports and exports) (kg/person)		
		Inland capture	Aqua-culture 3/	Total	Inland capture	Aqua-culture 3/	Total
1979	5 471	49 511	-	49 511	9.0	-	9.0
1980	5 648	50 987	-	50 987	9.0	-	9.0
1981	5 834	38 818	-	38 818	6.6	-	6.6
1982	6 029	55 737	72 5/	55 809	9.2	0.01	9.2
1983	6 232	67 032	202 5/	67 234	10.8	0.03	10.8
1984	6 445	64 282	339 5/	64 621	10.0	0.05	10.0
1985	6 666	67 368	363 5/	67 731	10.1	0.05	10.1
1986	6 898	67 504	695 5/	68 199	9.8	0.10	9.9
1987	7 139	66 980	1 020 5/	68 000	9.4	0.14	9.5

1/ Source: FAO

2/ Source: FAO Fisheries Department FISHDAB, based on National Statistics

3/ included in "Inland capture" if not specified

4/ - = data not available

5/ Vincke, 1989 (pers.comm.)

3.3 Inland catch range and potential yield

Table 2.

Water body	Period	Annual catch range (t) 1/	Potential annual yield (t) 1/
Bangweulu Lakes/ Swamp Complex	1982	11 006	20 000
Lake Chisi	1972	47	-
Lake Ishiba Ngandu	-	-	-
Lake Lusiwashi	1982	423	500
Lake Mwange	-	-	-
Lake Mweru/ Luapula Floodplain	1982	7 907	17 000
Lake Mweru Wa Ntipa	1982	10 979	13 000
Lake Tanganyika	1988	14 000	18 000
Luangwa River	1980	786	-
Middle Zambezi River	1981	750	-
Barotse Floodplain	1982	5 200	14 000
Lukanga Swamp	1982	2 601	8 000
Itezhitezhi Reservoir	1981	400	1 800
Kafue Flats/Gorge Reservoir Complex	1982	8 907	17 000
Kariba Reservoir	1982	3 500	8 000
Mita Hills Reservoir	-	-	-
Mulungushi Reservoir	-	-	-

1/ Sources: see text

Total annual yield: 66 500 t

Potential annual yield: 117 300 t

4. STATE OF THE FISHERY

[redrawn after Welcomme (1979a) and Coopconsult-Propesca (1982)]

4.1 Yield

The fishing activities of Zambia are carried on in an extremely rich variety of lakes, swamps, rivers, floodplains and other bodies of water (both natural and man made) which are distributed throughout the country. Each fishery area is physically different from the others, and the fishing activity that is carried on varies accordingly.

The introduction of *Limnothrissa miodon* in Lake Kariba in 1968 and the subsequent commencement of commercial fishing has greatly improved the potential yield for this area. In Lake Tanganyika there may be room for increased production with intensified exploitation of *Stolothrissa*, but the Zambian waters are already among the most intensively fished on the lake, and it is doubtful whether any considerable increase can be made. The Lake Mweru/Luapula fishery has been in decline for many years, with a progressive decline of favoured fish species such as *Labeo altivelis* and *Oreochromis macrochir*. However, the tonnage has been maintained through the fishing-up process which now exploits the smaller and faster-growing *Alestes*. The level of Lake Mweru Wa Ntipa is very variable and catches fluctuate from year to year depending on the rainfall. Lake Bangweulu has undergone a fishing-up process similar to Lake Mweru, with increased catches of less desirable species. It is doubtful if the process can continue indefinitely, and active measures to protect the fishery were being instituted in 1974.

The fishery of the Kafue Flats has been altered by the installation of dams upstream and downstream of the floodplain. The fish catch is very sensitive to fluctuations in water level and the status of the fishery is in doubt, due to the recent hydrological management of the system.

Two fisheries which are at present seemingly underexploited are the floodplain fisheries of the Zambezi, where considerable increase in catch can be anticipated, and the Lukanga Swamp.

The total production of the fisheries of Zambia is estimated at 60 000 t/yr on average. The catch/fisherman varies between a maximum of 2.8 t/yr on Lake Tanganyika and 2.6 t/yr in Mweru Wa Ntipa, down to 1.0 to 2.0 t/fisherman for the other fisheries.

Table 2 summarizes the production for each fishery.

4.2 Factors influencing yield

Several of the Zambian fisheries are on floodplains and are therefore sensitive to seasonal floods. Similarly, Lake Mweru Wa Ntipa fluctuates in level and yield. It is to be anticipated that the total fish catch from Zambia will vary widely, depending on the rainfall patterns.

In Lukanga, Bangweulu, Upper Zambezi, and the River Luapula, all floodplain or swamp fisheries, it is poor access and distance from main markets that depresses production. Overfishing does not generally appear to be a problem, although the increasing use of smaller meshes and improper techniques (such as fish driving and beach seines) give cause for concern. Many fisheries, particularly the floodplains and swamps, still have vast untouched areas.

Decline in the share of clupeids in catches of the industrial fleet of Lake Tanganyika is commonly attributed to effects of beach seines that are undoubtedly landing too many juveniles and immature fish, justifying their substitution.

4.3 Future development possibilities

The potential yield of Zambia's eight major fisheries (producing over 1 000 t/yr) can be estimated conservatively at 116 000 t/yr. In all of them except two, present yields are less than 55% of MSY. The exceptions are Mweru Wa Ntipa, where today's recorded output is equal to 84% of estimated MSY, and Lake Tanganyika (yielding 77% of potential). All the fishery areas except Mweru Wa Ntipa can support nearly double their present production levels, depending mainly on improved access and marketing. Increased yields can also be anticipated from the various reservoirs and from aquaculture.

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6. WATER BODIES DIRECTORY

Lakes

Bangweulu Lakes/Swamp Complex
Beu
Chisi
Ishiba Ngandu
Lusiwashi
Mwange
Mweru
Mweru Wa Ntipa
Tanganyika

Rivers

Kafue
Luangwa
Luapula
Zambezi

Floodplains and Swamps

Barotse Floodplain/Upper Zambezi River
Lukanga Swamp

Reservoirs

Itezhitezhi
Kariba
Mita Hills
Mulungushi
Kafue Flats/Gorge Reservoir Complex

BANGWEULU LAKES/SWAMP COMPLEX

The Bangweulu system is a complex of interconnecting lakes and swamps. The largest water bodies are known as Lakes Bangweulu, Chifanauli, Kampolombo, Kangwena, Walilupe. Lakes Katilye, Chofwe, Kasala, Kampondo, Chaya, Bemba, Chali, Chibambo and Pook as well as numerous other smaller lakes are also present.

Geographical data

Location:	Zambia - 10° 15'-12° 30'S; 29° 30'-30° 5'E	
Altitude:	1 160 m	
Surface area:	Lake Bangweulu and adjoining lakes	2 735 km^2
	Swamp and floodplain	12 271 km^2
	Lake islands	218 km^2
	Swamp islands	235 km^2
	Open waters in swamps	334 km^2

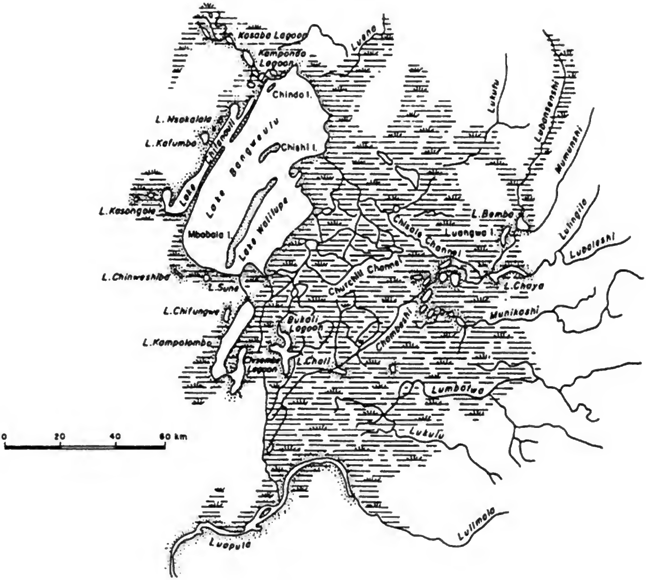

Fig. 2. LAKES AND SWAMPS OF THE BANGWEULU SYSTEM
(Welcomme, 1972)

BANGWEULU LAKES/SWAMP COMPLEX (cont.)

Data on individual components: (after Toews, 1975)

Lake Bangweulu

Surface area:..1 721 km^2
Max. length: 74 km
Max. width: 23 km
Depth: 4.14 m (mean); 9.7 m (max)
Volume: 7.44 km^3

Lake Walilupe

Surface area: 585 km^2
Max. length: 34 km
Max. width: 17 km (mean)
Depth: 2.72 m (mean); 4.7 m (max)
Volume: 1.66 km^3

Lake Chifanauli

Surface area: 225 km^2
Max. length: 42 km
Max. width: 5 km
Depth: 2 m (mean); 3 m (max)
Volume: 0.45 km^3

Lake Kampolombo

Surface area: 155 km^2
Max. length: 29 km
Max. width: 5 km
Depth: 2 m (mean); 3 m (max)
Volume: 0.31 km^3

Lake Kangwena

Surface area: 47 km^2
Max. length: 16 km
Max. width: 2.9 km
Depth: 1.5 m (mean); 2.0 m (max)
Volume: 71 x 10^6 m^3

Annual fluctuation in level:.1.2 m (mean)
Major inflowing river: Chambezi
Outflowing river: Luapula
Catchment area: 109 469 km^2

Physical and chemical data:

	Lake Bangweulu		Lakes Chifanauli, Kampolombo & Kangwena
	South	North	
Surf. temp. $^\circ$*C:*	18.3-26.6	18.3-27.1	18.8-26.6
pH:	6.9-7.2	6.8-7.2	7.0-8.4
Conductivity: (K_{25} μS/cm)	21.4-29.5	20.1-29.6	21.9-30.0
Alkalinity: (mg/l $CaCO_3$)	8.5-11.6	7.6-11.6	8.6-12.1

BANGWEULU LAKES/SWAMP COMPLEX (cont.)

Ionic composition: (mg/l)

	Lakes				
	Bangweulu		Chifanauli	Chali	Sume
	South	North			
Ca	2.0-3.0	1.8-2.8	2.0-2.7	2.0-3.0	4.0-5.0
Mg	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0
Na	2.0	1.7-2.0	2.0	2.0	2.0
K	0.5	0.5	0.5	0.5	0.5
HCO_3	9.8-17.1	10.2-14.6	8.7-16.3	10.2-16.3	16.3-24.5
Cl	2.0	1.7-2.0	2.0	2.0	2.0
SiO_2	11.5-16.0	14.0-16.0	13.3-16.0	16.0	16.0

Fisheries data

No. of fish species: 86 (Mortimer, 1965)

No. of fishermen: 7 900 in 1980-82, Bangweulu Lake and Swamp (Coopconsult-Propesca, 1982)

No. of boats: 4 360 dug-out canoes; 140 plankboats; no engine in 1980-82, Bangweulu Lake and Swamp (Coopconsult-Propesca, 1982).

Comments: Fishing in swamps as waters recede; lakes virtually untouched. Waterways choked by vegetation or silted up due to lack of maintenance prompts fishermen to stay near landing points. Low catch per unit effort attributed to low biological productivity (papyrus swamp). (Coopconsult-Propesca, 1982)

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1966*	12 408	-	-
1967*	11 894	-	-
1968*	11 430	-	-
1969*	11 894	-	-
1970*	12 375	-	-
1971*	11 728	-	-
1972*	13 034	-	-
1973*	15 123	-	-
1974*	14 620	-	8 739
1975	9 881	7 969	4 493
1976	7 598	-	-
1977	9 496	-	-
1978	8 942	-	-
1979	11 648	-	-
1980	10 366	-	-
1981	9 343	-	-
1982	11 006	-	-

* Source: 1966-74: Bazigos *et al.*, 1975

Potential annual yield: 20 000 t (Coopconsult-Propesca, 1982)

Specific reference: Toews, 1975

LAKE BEU

Geographical data

Location:	Zambia - 11° 49'S; 33° 11'E

LAKE CHISI

Geographical data

Location:	Zambia - 8° 54'S; 29° 47'E
Surface area:	variable; 34-60 km^2 of open water (total area: 100-170 km^2)
Depth:	7 m (max); 2.5 m (mean)
Special features:	part of Lake Mweru Wa Ntipa complex. During years of low water level Lake Chisi becomes separated from Lake Mweru Wa Ntipa.

Physical and chemical data:

Conductivity:	115 μS/cm
Total dissolved solids:	82 mg/l

Fisheries data

Total annual catch and effort:

Year	Total catch (t)	No.of Fishermen
1953	-	21
1954	288	61
1955	339	60
1956	197	60
1957	125	30
1958	281	40
1959	307	40
1960	235	40
1961	190	30
1962	150	36
1963	154	28
1964	432	26
1965	482	41
1966	360	28
1967	402	38
1968	197	28
1969	185	25
1970	118	20
1971	72	13
1972	47	8

LAKE ISHIBA NGANDU

Geographical data

Location:	Zambia - 11° 14'S; 31° 15'E
Surface area:	3.2 km^2
Max. length:	4.5 km
Max. width	1.0 km
Outflowing river:	Mansha

LAKE LUSIWASHI

Geographical data
Location: Zambia - 12° 58'S; 30° 46'E
Surface area: 80 km^2
Max. length: 19 km
Max. width: 9 km
Outflowing river: Lukusashi

Fisheries data
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1970	18	-	-
1971	40	-	-
1972	82	-	-
1973-77	-	-	-
1978	277	-	-
1979	255	-	-
1980	339	-	-
1981	300	163	118
1982	423	-	-

Potential annual yield: 500 t (Coopconsult-Propesca, 1982)

LAKE MWANGE

Geographical data
Location: Zambia - 13° 34'S; 22° 26'E
Surface area: 2.8 km^2
Max. length: 4 km
Max. width 1 km
Major inflowing river: Litapi (Zambezi tributary)
Outflowing river: Litapi

LAKE MWERU
(International water)

Geographical data (see Fig. 3)
Location: Zaire, Zambia - 8° 28'-9° 31'S; 28° 20'-29° 10'E
Altitude: 930 m
Surface area: Zaire 1 950 km^2 (42%)
Zambia 2 700 km^2 (58%)
Total 4 650 km^2 (Konare, 1984)
Depth: 37 m (max); 10 m (mean: N. basin); 3 m (mean: S. basin)
Volume: 38 km^3 (15 km^3 in Zaire, 23 km^3 in Zambia)
Max. length: 124 km
Max. width: 51 km
Shoreline: 350 km (140 km in Zaire, 210 km in Zambia)
Annual fluctuation in level: 5 m (max); 1.5 m (mean)
Major inflowing rivers: Luapula, Kalungwishi
Outflowing river: Luvua into Lualaba
Special features: the inflowing Luapula River is flanked from both sides of its course between the Johnson Falls at its point of discharge into Lake Mweru by an extensive floodplain (the Luapula Floodplain), covering 1 500 to 2 400 km^2 with scattered permanent lagoons. This area is known as the Kifakula Depression.

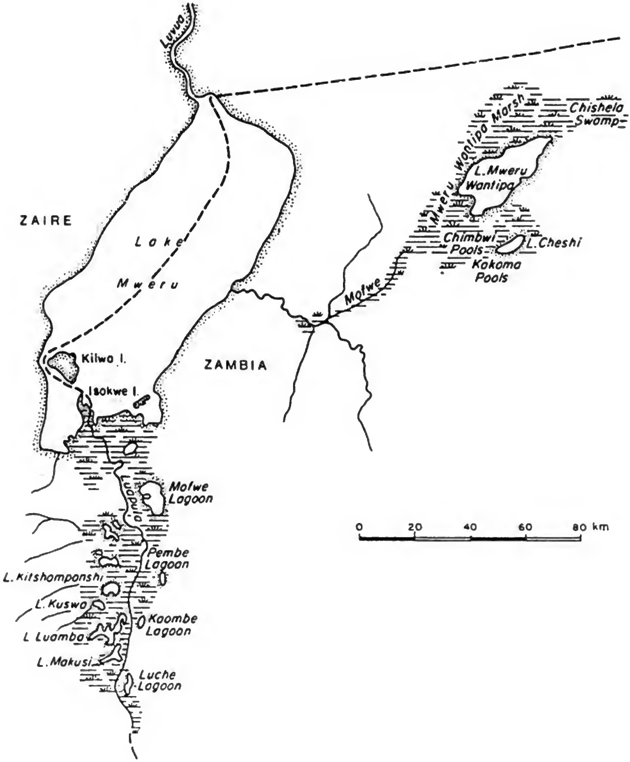

Fig. 3. LAKE MWERU,, THE KIFAKULA DEPRESSION,
LAKE MWERU WA NTIPA, AND LUAPULA SWAMPS
(Welcomme, 1972)

LAKE MWERU (cont.)

Physical and chemical data:

Surface temperature: 19-30° C

Conductivity: K_{20} 70-125 μS/cm (De Kimpe, 1960)

Dissolved solids: 76 mg/l (Stappers, 1914)

pH: 6.4-9.3 (De Kimpe, 1960)
8.5 (Konare, 1984)

Oxygen: 5.4-8.9 mg/l; 70-120% saturation (Compere & Symoens, 1987)

Ionic composition:

	(Stappers, 1914) mg/l	(Talling & Talling, 1965) mg/l
Na	-	4.06
K	-	1.25
Ca	13.07	7.05
Mg	6.0	5.01
HCO_3+CO_3	48.08	48.08
Cl	19.08	5.0
SO_4	-	3.07
SiO_2	1.03	10.05

Fisheries data

No. of fish species: over 100 species; 27 are of fishing interest:
mainly: *Oreochromis macrochir* (80%); *Clarias spp; Synodontis sp.*, *Barbus altivelis*, Mormyridae (Konare, 1984)

No. of fishermen: in Zambia, in 1980-82: (Coopconsult-Propesca, 1982)
3 570 - Lake Mweru
3 640 - Luapula River and floodplain

No. of boats: in Zambia, in 1980-82: (Coopconsult-Propesca, 1982)

	Lake Mweru	Luapula River/ floodplain
dugout canoes	734	1 790
plank boats	1 103	207
fiberglass	145	25
with engine	250-300	100

Total annual catch and effort: in Zambia

Year	Total catch (t)	No.of boats
Lake Mweru, including Luapula River and floodplain		
1966*	9 479	-
1967*	7 543	-
1968*	7 617	-
1969*	7 717	-
1970*	7 326	-
1971*	8 342	-
1972*	9 068	-
1973*	8 031	-
1974*	8 135	-
1975	8 483	-
1976	10 680	-
1977	9 534	-
1978	7 629	2 896
1979	9 438	-
1980	7 663	-
1981	-	-
1982	7 907	-
Luapula River and floodplain		
1973*	3 600	1 219
1974*	3 700	-

* Source: 1966-1974: Bazigos *et al.*, 1975

LAKE MWERU (cont.)

Fisheries data (cont.)
Potential annual yield:
17 000 t in Zambia (including Luapula River) (Coopconsult-Propesca, 1982)
12 000 t in Zaire
16 000 t in Zambia
28 000 t total (Konare, 1984)
35 000-52 000 t/yr for entire Luapula-Mweru system (cited by Compere & Symoens, 1987)
Productivity: 60 kg/ha (cited by FAO, 1983c)
50 kg/ha (De Kimpe, 1960)
Specific reference: De Kimpe, 1960, 1964

LAKE MWERU WA NTIPA

Geographical data (Welcomme, 1972)
Location: Zambia - 8° 44'S; 29° 45'E (see Fig. 3)
Altitude: 928 m
Surface area: Open water: 1 600 km^2; surrounding swamp: 1 200 km^2; Lake Chesi: 60 km^2
Depth: 9 m (max); 3 m (mean)
Max. length: 105 km
Max. width: 25 km
Catchment area: 11 900 km^2
Annual fluctuation in level: the lake follows a cycle of about 15 years' duration, with a possibility of dessication periodically.
In 1964 the cycle reached a maximum, with depth of 9.14 m.
Major inflowing river: direct drainage, Kalungwishi
Outflowing river: communicates with Lake Mweru via the swampy Mofure depression when full.

Physical and chemical data: (Welcomme, 1972)
Surface temperature: 19-28° C
Conductivity: K_{20} 600 μS/cm
Dissolved solids: 429 mg/l
pH: 8.2

Fisheries data
Main catches: *Oreochromis macrochir*
No. of fishermen: 3 500 in 1980-82 (Coopconsult-Propesca, 1982)
No. of boats: in 1980-82: (Coopconsult-Propesca, 1982)
110 dug-out canoes
1 530 plank boats
160 fiberglass boats
320 with engine

Comments: Ex-swamp that was virtually dry in the late 1950's. Conflicting land use with national park. Market-oriented gill-net fishery is landing 90% good-sized tilapia (*Oreochromis macrochir*). (Coopconsult-Propesca, 1982)

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1966*	1 672	-	-
1967*	2 865	-	-
1968*	3 704	-	-

LAKE MWERU WANTIPA (cont.)

Fisheries data (cont.)

Year	Total catch (t)	No.of fishermen	No.of boats
1969*	4 125	-	-
1970*	4 216	-	-
1971*	3 825	-	-
1972*	5 812	-	-
1973*	8 113	-	1 200
1974*	5 992	-	-
1975	16 765	-	-
1976	13 330	-	-
1977	12 521	2 124	1 407
1978	10 352	-	-
1979	7 878	-	-
1980	9 094	-	-
1981	-	-	-
1982	10 979	-	-

* Source: 1966-1974: Bazigos *et al.*, 1975

Potential annual yield: 13 000 t (Coopconsult-Propesca, 1982)

LAKE TANGANYIKA
(International water)

Geographical data (see Fig. 4)

Location: Burundi, Tanzania, Zaire, Zambia - 3° 20'-8° 50'S; 30° E;

Altitude: 773 m

Surface area:

Burundi	2 600 km^2	(8%)
Tanzania	13 500 km^2	(41%)
Zaire	14 800 km^2	(45%)
Zambia	2 000 km^2	(6%)
Total	32 900 km^2	

Depth: 1 435 m (max); 700 m (mean)

Volume: 18 940 km^3 (1 140 km^3 in Zambia)

Max. length: 673 km

Max. width: 48 km

Shoreline: 1 500 km total; (150 km in Zambia)

Catchment area: 249 000 km^2

Major inflowing river: Malagarasi, Ruzizi

Outflowing river: Lukuga

Physical and chemical data (Talling & Talling, 1965)

Conductivity: K_{20} 520-610 μS/cm

pH: 7.3-7.8

Oxygen limit: 80 m, North Basin; 150 m, South Basin (Aubray, 1976)

Photosynthetic production: 0.8-1.1 gC/m^2 day (Melack, 1976)

Ionic composition:

	mg/l
Na	57.0
K	35.0
Ca	9.3
Mg	43.3
Cl	26.5
SO_4	5.0
SiO_2	0.38
HCO_3+CO_3	409.3

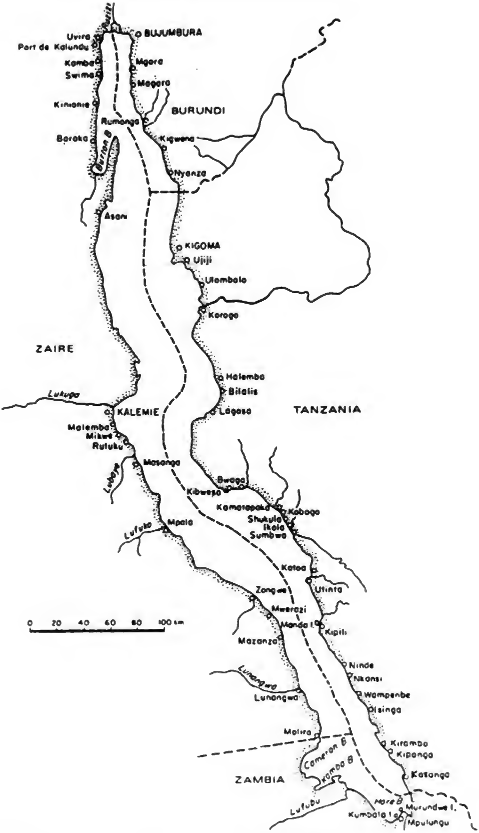

Fig. 4. LAKE TANGANYIKA
(Welcomme, 1972)

LAKE TANGANYIKA (cont.)

Fisheries data

No. of fish species: 214 (134 belong to the Cichlidae family) (Greenwood, 1964)

Main catches: (Aubray, 1976)

Clupeidae:
Stolothrissa tanganicae: 75%
Limnothrissa miodon: 10%
Centropomidae: 15%
Lates spp. (3 species), *Luciolates stappersi*

No. of fishermen in Zambia:
in 1976: 1 356
in 1980-82: 1 800 + 4 600 helpers (Coopconsult-Propesca, 1982)
in 1988: 2 000 (Mikkola & Lindquist, 1989)

No. of boats in Zambia:
in 1974: 635 (Bazigos *et al.*, 1975)
in 1976: 1 096 (Bazigos *et al.*, 1975)
in 1980-82: (Coopconsult-Propesca, 1982)
1 240 total
220 dugout canoes
980 plankboats
40 fiberglass
(130 with engine)
in 1988: (Mikkola & Lindquist, 1989)
270 total
19 industrial fishing units (purse seiners)
1 artisanal fishing unit (lift nets, etc.)
250 coastal canoe fishing units

Total annual catch and effort:

in Zambia:

Year	Total catch (t)	No.of fishermen	No.of boats
1966*	6 500	-	-
1967*	11 968	-	-
1968*	10 104	-	-
1969*	7 066	-	-
1970*	10 835	-	-
1971*	6 988	-	-
1972*	6 281	-	-
1973*	5 488	-	-
1974*	4 522	-	635
1975	7 440	-	-
1976	6 501	1 356	1 096
1977	7 866	-	-
1978	6 474	-	-
1979	-	-	-
1980	8 256	-	-
1981	-	-	-
1982	8 010	-	-
1988**	14 000	2 000	-

* 1966-1974: Bazigos *et al.*, 1975
** 1988: Mikkola & Lindquist, 1989

in Lake:	1982 (Corsi *et al.*, 1986)	1988 (Mikkola & Lindquist, 1989)
Burundi	13 600	16 000
Tanzania	25 000	25 000
Zaire	30 000	30 000
Zambia	10 500	14 000
Total	80 000	85 000

LAKE TANGANYIKA (cont.)

Fisheries data (cont.)
Potential annual yield:
in Zambia: 18 000 t (Mikkola & Lindquist, 1989)
19 000 t (Welcomme, 1972; Coopconsult-Propesca, 1982; Corsi *et al.*, 1986)
in Lake:

	(Corsi *et al.*, 1986) (t)	(Mikkola & Lindquist, 1989) (max. t)
Burundi	21 000	23 000
Tanzania	122 000	121 000
Zaire	135 000	133 000
Zambia	19 000	18 000
Total	300 000 (90 kg/ha)	295 000

KAFUE RIVER

Geographical data (see Figs. 1 and 5)
Source: near Ndola
Altitude: 1 513 m asl
Total length: 945 km
Drainage area: 154 200 km^2
Countries traversed: Zambia
Major tributaries: Lufupa, Mushingoshi
Discharges to: Luswishi
Volume of discharge at mouth: 10.3 km^3 per year (range: 2-30 km^3)
Flood regime: high water from January to May
Special features: Lukanga Swamp, Itezhitezhi Reservoir, Kafue Flats/Gorge Reservoir

Physical and chemical data: see entry "Kafue Flats" under Reservoirs

Fisheries data: see entry "Kafue Flats" under Reservoirs

LUANGWA RIVER
(International water)

Geographical data
Source: near Zambia/Malawi frontier
Altitude: 1 658 m asl
Total length: 790 km
(710 km in Zambia; 80 km along Zambian/Mozambique frontier)
Drainage area: 147 500 km^2
Countries traversed: Zambia, Mozambique
Major tributaries: Lukusashi, Lusemfwa
Discharges to: Cahora Bassa Reservoir confluently with the Zambezi River
Volume of discharge at mouth: 8 km^3 per year
Flood regime: main discharge from April to July
Special features: two reservoirs (Mulungushi and Mita Hills) within the Lusemfwa tributary basin)

Fisheries data
Total annual catch: 786 t in 1980 (Fisheries Dept. estimate, Govt. of Zambia; cited in Coopconsult-Propesca, 1982)

LUAPULA RIVER

(International water)

Geographical data (see Fig. 3)
Source: Lake Bangweulu, Zambia
Altitude: 1 140 m asl
Total length: 560 km
Countries traversed: Zambia, Zaire
Discharges to: Lake Mweru
Special features: the Luapula flows through an extensive swamp system which occupies the Kifukula depression. This stretches from Johnson Falls to Lake Mweru, a distance of some 160 km and a width of 5-18 km. The total area of the swamp is 1 500 km^2 during the wet season, when a depth of between 5 and 10 m is attained. The extent of the flooding varies from year to year. Larger permanent lakes on the floodplain include Kifikula and Kitshomponshi in Zaire and Mofwe, Pembe and Kaombe in Zambia.

Physical and chemical data:
Conductivity: 150-180 μS/cm
24.5 μS/cm (Toews, pers.comm.)
pH: 6.2 (Toews, pers.comm.)

Fisheries data: see entry: "Lake Mweru"

ZAMBEZI RIVER

(International water)

Geographical data (see Figs. 1 and 5)
Source: northwest Zambia and eastern Angola
Altitude: 1 600 m
Total length: 2 574 km
Drainage area: 1 300 000 km^2
Countries traversed: Angola, Mozambique, Zambia, Botswana, Namibia, Zimbabwe
Major tributaries: Cuando, Kafue, Luangwa, Shire. The Zambezi system also communicates with the Okovango system via the Chobe River.
Discharges to: Indian Ocean - 18° 47'S; 36° E
Volume of discharge at mouth: 7 070 km^3/sec
Flood regime: December to July, maximum in March
Special features: Barotse floodplain 700-9 000 km^2, Kafue flats (200-7 000 km^2), Lukanga swamps (3 000-8 000 km^2), Kariba and Cahora Bassa dams/reservoirs.

Physical and chemical data above Lake Kariba (Coche, 1968)

		Flood	Low water
Temperature: °C		30	17
pH:		-	7.4
Conductivity: K_{20}		50 μS/cm	96 μS/cm
Total alkalinity:		20 mg/l	44 mg/l
Total hardness:		17.9 mg/l	38.1 mg/l
Ionic composition:		mg/l	mg/l
	Na	1.70	3.26
	K	-	0 88
	Ca	4.93	-
	Mg	1.47	3.86
	NO_2-N	0.00376	0.00024
	NO_3-N	0.0047	0.0158
	PO_4-P	0.0295	0.0078

ZAMBEZI RIVER (cont.)

Fisheries data

No. of fish species: Upper Zambezi: 49; Middle Zambezi: 50 (Jubb, 1961)

Total annual catch in Zambia:
Middle Zambezi (between Kariba dam and Cahora Bassa Reservoir): 750 t in 1981
Upper Zambezi: see entry "Barotse Floodplain", below.

BAROTSE FLOODPLAIN/UPPER ZAMBEZI RIVER

Geographical data

Location: Zambia - 15° 30'S; 23° E (see Zambezi River)
Formed by lateral flooding of Upper Zambezi River
Surface area: 700 km^2 - dry season;
7 800 km^2 - wet season, central plain;
3 100 km^2 - wet season, southern plain
Depth: 5 m during floods
Max. length: central plain: 241 km; southern plain: 97 km
Max. width: central plain: 32 km; southern plain: 32 km
Flood regime: February-June, peak in April
Special features: contains numerous small lakes (i.e. Silita, Njolo, Siwa, Chilele, Sihole).

Physical and chemical data:

Conductivity: K_{20} 57-102 μS/cm (FAO/UN, 1969)

Fisheries data

Main catches: Cichlids, *Hydrocynus* *sp.*
No. of fishermen: 3 400 in 1980/82 (Coopconsult-Propesca, 1982)
No. of boats: 2 179 dug-out canoes in 1980/82 (Coopconsult-Propesca, 1982)
Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1966*	1 000	-	-
1967*	1 000	-	-
1968*	1 000	-	-
1969*	1 000	-	-
1970*	3 500	-	-
1971*	3 500	-	-
1972*	3 500	-	-
1973*	3 500	-	1 734
1974*	3 500	-	-
1975	5 827	-	-
1976	5 995	1 358	2 734
1977	3 490	-	-
1978	4 475	-	-
1979	5 559	-	-
1980	6 572	-	-
1981	6 691	-	-
1982	5 200	-	-

* Source: Bazigos *et al.*, 1975

Potential annual yield: 14 000 t (Coopconsult-Propesca, 1982)

Specific reference: FAO/UN (1969, 1970)

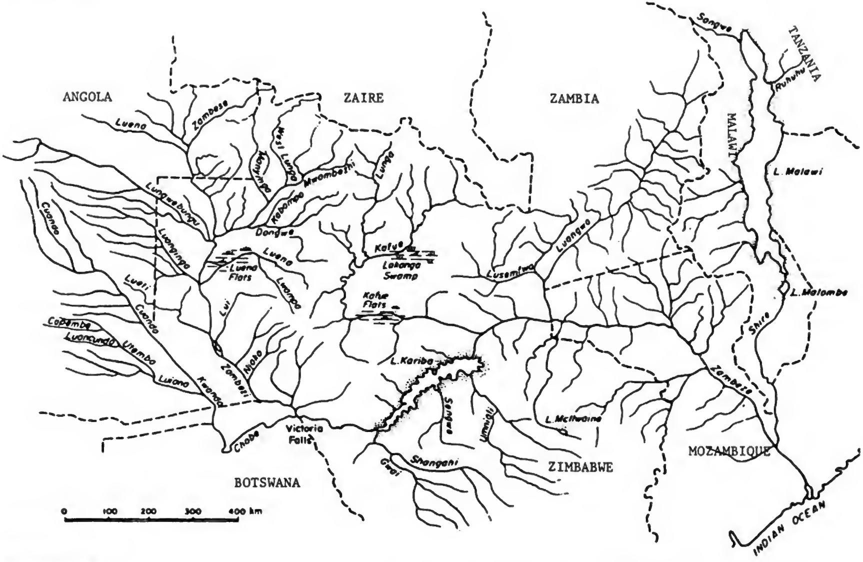

Fig. 5. RIVERS AND LAKES OF THE ZAMBEZI
(Welcomme, 1972)

LUKANGA SWAMP

Geographical data

Location: Zambia - 14° 25'S; 27° 45'E

Surface area: 8 000 km^2 at high water; 3 000 km^2 at low water

Max. length: 80 km

Max. width: 65 km

Major inflowing rivers: Kafue (lateral flooding); Lukanga

Fisheries data

Main catches: Cichlids, *Alestes sp.* (Coopconsult-Propesca, 1982)

No. of fishermen: 1 300 in 1980-82 (Coopconsult-Propesca, 1982)

No. of boats: 1 000 in 1980-82 (Coopconsult-Propesca, 1982)
(980 dug-out canoes; 20 plank boats)

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1965	-	-	507
1966*	658	-	-
1967*	955	-	-
1968*	1 602	-	-
1969*	1 366	-	-
1970*	1 724	-	-
1971*	1 900	-	-
1972*	2 370	-	-
1973*	1 801	-	543
1974*	1 707	-	-
1975	1 802	-	-
1976	856	689	516
1977	1 005	-	-
1978	786	-	-
1979	765	-	-
1980	549**	-	-
1981	-	-	-
1982	2 601	-	-

* Source: Bazigos *et al.*, 1975

** Total catch in 1980: 3 500 t (Coopconsult-Propesca, 1982)

Potential annual yield: 8 000 t (Coopconsult-Propesca, 1982)

ITEZHITEZHI RESERVOIR

Geographical data

Location: Zambia

Altitude: 1 029.5 m asl

Surface area: 360 km^2

Major inflowing river: Kafue

Outflowing river: Kafue

Fisheries data

No. of fishermen: 290 (1981)

No. of boats: 253 (1981)

Total annual catch: 400 t (1981)

Potential annual yield: 1 800 t (Coopconsult-Propesca, 1982)

KARIBA RESERVOIR
(International water)

Geographical data (see Fig. 6)
Location: Zimbabwe, Zambia
16° 28'-18° 04'S; 26° 42'-29° 03'E
Date closed: 1958
Altitude: 485 m
Surface area: Zimbabwe 2 952 km^2 (55%)
Zambia 2 412 km^2 (45%)
Total 5 364 km^2
Depth: 120 m (max); 29.2 m (mean)
Volume: 156 km^3
Max. length: 277 km
Max. width: 40 km
Shoreline: 2 164 km
Catchment area: 823 200 km^2
Annual fluctuation in level: 3-4 m
Major inflowing rivers: Zambesi, Umiali
Outflowing river: Zambesi

Physical and chemical data
Surface temperature: 17-32° C.
Lake overturns once a year between March and July.
Monothermy about 22° C.
Dissolved solids: 40-70 mg/l

		(Harding, 1961)	(Coche, 1968 and 1969)	
			Basins I & II	*Basins III & IV*
Conductivity:	μS/cm	-	K_{25} 50-100	K_{20} 88-115
pH:		-	7.5-8.0	7.8-8.9
Ionic composition:		mg/l	mg/l	mg/l
	Na	5-8	1.8-3.6	3.2-4.7
	K	-	trace-1.8	0.6-1.6
	Ca	12.4-14	2-10	7-13
	Mg	2.0-3.6	0.5-3	0.5-3
	HCO_3+CO_3	62.2-72.0	-	-
	Cl	1-3	-	-
	SO_4	2.5-3	-	-
	NO_2-N	-	0-0.002	0-0.004
	NO_3-N	-	0.003-0.04	0.010-0.050
	PO_4-P	-	0-0.05	0.01-0.05

Fisheries data
No. of fish species: 46 (Jackson, 1971)
Limnothrissa miodon was introduced in 1967-68.
Main catches: *Limnothrissa miodon, Hydrocynus vittatus*, mormyrids, tilapias (Marshall, 1984a; Balarin, 1984)
No. of fishermen: 1 000 in Zambia in 1980-82 (Coopconsult-Propesca, 1982)
No. of boats: 512 in Zambia in 1980-82 (Coopconsult-Propesca, 1982):
420 dug-out canoes
56 plank boats
36 fiberglass boats
+37 steel crafts (not in operating condition)

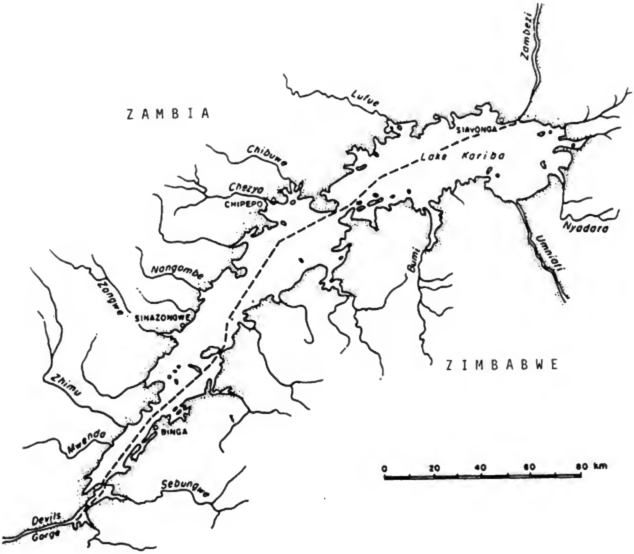

Fig. 6. LAKE KARIBA
(Welcomme, 1972)

KARIBA RESERVOIR (cont.)

Fisheries data (cont.)
Total annual catch: in Zambia

Year	Total catch (t)	No.of fishermen	No.of boats
1966*	1 436	-	-
1967*	980	-	-
1968*	1 410	-	-
1969*	1 345	-	-
1970*	2 581	-	-
1971*	2 311	-	294
1972*	1 955	-	-
1973*	3 058	-	-
1974*	2 181	-	-
1975-79	-	-	-
1980**	1 000	1 000	512
1982	3 500	-	-

Sources: * 1966-74: Bazigos *et al.*, 1975
** 1980: Coopconsult-Propesca, 1982

Potential annual yield:
8 000 t in Zambia (Coopconsult-Propesca, 1982)

Productivity: 23.2 kg/ha/yr based on MEI relationship (Marshall, 1984c)

Specific references:
Entz, 1984
Kapetsky & Petr, 1984
Marshall, 1984a,b,c

MITA HILLS RESERVOIR

Geographical data
Location: Zambia - 14° 10'S; 29° 06'E
Surface area: 50 km^2
Max. length: 29 km
Max. width: 2.5 km
Major inflowing river: Lunsemfwa
Outflowing river: Lunsemfwa

MULUNGUSHI RESERVOIR

Geographical data
Location: Zambia - 14° 40'S; 28° 49'E
Surface area: 24 km^2
Max. length: 17 km
Max. width: 2 km
Major inflowing river: Mulungushi
Outflowing river: Mulungushi

KAFUE FLATS/GORGE RESERVOIR COMPLEX

Geographical data (see Figs. 1 and 5)

Location:	Zambia on Kafue River
Altitude:	1 021 m asl at upstream end; 976.6 m USL at Kafue Gorge dam
Dam height:	45 m
Date closed:	1972
Surface area:	4 340 km^2 during wet season; 600-1 600 km^2 during dry season
Depth:	2 m (wet season)
Volume:	0.8 km^3 for Kafue Gorge Reservoir
Max. length:	425 km
Max. width:	9.7 km
Catchment area:	45 325 km^2
Annual fluctuation in level:	3.3 m (mean)
Major inflowing river:	Kafue (outflow from Itezhitezhi dam)
Outflowing river:	Kafue
Special features:	regulation of the Kafue River above (Itezhitezhi dam, closed in 1977) and below (Kafue Gorge dam, closed in 1972) the flats alters the natural flooding regime by decreasing and regularizing the maximum area flooded, decreasing the flood duration, delaying the flood, increasing the area permanently flooded during the dry season and reducing the amplitude of water level fluctuation by raising the minimum level.

Physical and chemical data

Surface temperature:	17-33° C (24° C mean)
Conductivity:	K_{25} 140-382 μS/cm
Dissolved solids:	68-220 mg/l
pH:	6.7-8.2

Ionic composition:

	mg/l
Na	3.5-8.5
K	1.17-3.13
Ca	15.8-45.3
Mg	4.1-18.0
HCO_3+CO_3	73.2-268.4
Cl	0-3.55

Fisheries data

Main catches:	*Oreochromis macrochir* and other cichlids
No. of fishermen:	4 000 in 1980-82 (Coopconsult-Propesca, 1982)
No. of boats:	2 200 in 1980-82 (Coopconsult-Propesca, 1982) (1 750 dug-out canoes; 450 fiberglass boats)

Total annual catch and effort:

Year	Total catch (t)	No.of fishermen	No.of boats
1966*	10 709	-	-
1967*	3 941	-	-
1968*	6 183	-	-
1969*	9 938	-	-
1970*	9 582	1 262	1 163
1971*	8 247	-	-
1972*	7 874	-	-
1973*	6 289	1 034	1 021
1974*	5 177	-	-
1975	7 226	-	-
1976	9 306	-	-

KAFUE FLATS/GORGE RESERVOIR COMPLEX (cont.)

Fisheries data (cont.)

Year	Total catch (t)	No.of fishermen	No.of boats
1977	9 829	-	-
1978	8 634	2 632	1 790
1979	10 851	-	-
1980	7 741	-	-
1981	9 619	-	-
1982	8 907	-	-

* Source: 1966-74: Bazigos *et al.*, 1975

Potential annual yield: 17 000 t (Coopconsult-Propesca, 1982)

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ZIMBABWE

1. GEOGRAPHY AND CLIMATE

Zimbabwe (with a surface area of 386 670 km^2) is a landlocked country, straddling the high plateau between the Zambezi and Limpopo rivers. The plateau consists of three relief regions: the high veld (over 1 200 m); the middle veld (915 to 1 220 m) and the low veld (below 915 m). The latter comprises the Zambezi basin in the north and the bigger Limpopo and Sabi-Lundi basins in the south and southeast, respectively.

The three relief regions have undulating plateaus with surfaces broken locally by rock formations, some of which are large landforms such as the Great Dyke (480 km long by 10 km wide). The border with Mozambique constitutes a fourth relief region known as the Eastern Highlands. This region marks the uplifted edge of the tableland of south-central Africa and is extremely mountainous, with many peaks exceeding 1 800 m (i.e., Mt. Inyangani: 2 594 m).

This wide range of altitude tends to moderate temperatures. On the high veld, mean monthly temperatures range from 13°C (July) to 22°C (October). Comparative values for the low-lying Zambezi Basin are 20°C to 30°C. Rainfall varies but is insufficient. It is restricted to the period between November and March. In the Eastern Highlands, the mean annual rainfall is 1 400 mm, while the northeastern highveld and the Limpopo basin receive about 800 and 400 mm, respectively.

The wide range of rainfall and the mixture of physical formations have given rise to the following different agricultural regions:

(a) diversified farming on the high and middle velds;
(b) intensive crop production, as for (a);
(c) extensive livestock farming (wet areas);
(d) extensive ranching (semi-arid areas); and
(e) land unsuitable for agriculture (4%).

Over 70% of the total population is agrarian and agriculture provides about 50% of the country's foreign exchange earnings. Mining accounts for 40%; the remaining percentage comes from manufacturing, tourism and other small industries.

2. HYDROGRAPHY

2.1 Lakes

There are no natural lakes of any significant size in Zimbabwe.

2.2 Rivers, Floodplains and Swamps

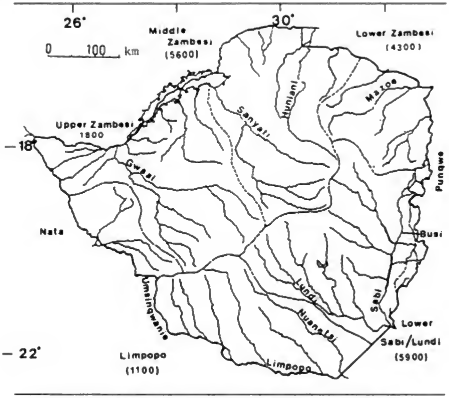
Rivers form the bulk of Zimbabwe's surface water resources and have a mean annual runoff exceeding 20.1 x 10^9 m^3. River flows are variable and characteristically seasonal, with the largest flows occurring during the rainy season (November to March). There are seven major river systems within Zimbabwe which carry about 65% of its runoff, while the balance (35%) originates from the country's northern (Zambia) and southern (South Africa) borders.

Zimbabwe can be divided into six hydrological zones (shown in Table 1), each of which is well provided with gauging weirs and flow-measuring devices. In 1975 there were about 866 gauging weirs, the earliest of which dates back to 1907.

Table 1. MAJOR RIVER SYSTEMS AND HYDROLOGICAL ZONES IN ZIMBABWE
(Balarin, 1984)

HYDROLOGICAL ZONE DRAINAGE BASIN/ Major River	Catchment area (10^3 km^2) a/	Mean Annual Runoff (MAR) (10^6 m^3) a/	Mean Annual Runoff (MAR) % total a/	Total MAR (10^6 m^3) b/	Total MAR (%) b/	Number of fish species c/
Zone A:						
UPPER ZAMBESI/ Gwaai	33.2	600	2.0	1 800	9.0	65
NATA SYSTEM/ Nata	-	-	-	-	-	4
Zone B:						
LIMPOPO SYSTEM/Nuanetsi	14.6	400	1.7	1 100	5.5	38
Umzinqwane	11.1	300	1.3			
Zone C:						
MIDDLE ZAMBESI/Sanyati	43.2	2 300	11.6	5 600	28.0	49
Hanyani	14.2	1 400	7.0			
Zone D:						
LOWER ZAMBESI/Mazoe	25.5	2 800	14.0	4 300	21.5	42
Ruenya	-					
Zone E:						
SABI-LUNDI SYSTEM/Sabi	73.9	5 200	25.9	5 900	29.5	32 (upper)
Lundi	-					37 (lower)
Zone F:						
PUNGWE SYSTEM/Pungwe	-			1 300	6.5	20
BUSI SYSTEM/Busi	-					14
TOTAL				20 000		

a/ Thornton, 1980
b/ Mitchell, 1977
c/ Bell-Cross, 1976



(1100) = mean annual runoff, million cubic metres

Fig. 1. MAJOR RIVERS AND DRAINAGE BASINS
(Bell-Cross, 1976; Mitchell, 1977)

Figure 3 shows the location of the floodplains of Zimbabwe. The largest floodplain is the Mana Pools in the Zambezi River between Kariba and Mpata gorges. Floodplains are prone to periodic flooding along the banks of rivers and little is known of their limnological or fishery potential.

2.3 Reservoirs (Balarin, 1984)

There exist about 120 large dams (as classified by the International Commission on Large Dams/ICOLD). The total capacity is over 3 900 million m^3. Cayron and De Fooz (1981) indicate 121 dams of 4 088 million m^3. These have been mainly constructed by the Ministry of Water Development for domestic, industrial and hydroelectric purposes. In 1979, some 7 400 small dams of varying sizes, with a total storage capacity of 4 700 million m^3, had been constructed (Grizic, 1980). Of these, 5 800 small dams had been built by the private sector, mainly in the farming areas (an estimated 21-45 000 ha of surface water, or 446 million m^3) (Kenmuir, 1981b). Cayron and De Fooz (1981) consider all sizes of small dams and suggest that these are over 14 511, with a total capacity of 5 236 million m^3. This could perhaps include the weirs described by Bowmaker (1975). The location of some of the major dams of over 10 million m^3 capacity are shown in Figure 2 and described in Table 2 (Thornton, 1980). The 34 dams listed have been the subject of limnological studies and their uses are also indicated.

Over 8 000 small dams now exist, of which 75% are private farm dams. These impoundments are shallow, monomictic (overturn in April), and highly seasonal water bodies. Evaporation losses from a dam average 1 800 mm/yr (Mitchell, 1977). This, coupled with water use, causes dramatic seasonal fluctuations. The nutrient load is low (meso-oligotrophic status), though water quality in certain impoundments is affected by man. Lake McIlwaine, for example, used to receive processed sewage from Hahare and became highly eutrophic.

2.4 Coastal Lagoons

None; Zimbabwe is landlocked.

3. FISHERY PRODUCTION/POTENTIAL

3.1 Aquaculture (mainly adapted from Balarin, 1984)

Fish farming trials were first undertaken in 1950. In 1956, the first fish culture research station was built at Henderson under the auspices of the Department of Research and Specialist Service. This station was closed down in 1973 and a new station was built in 1970-71 at Lake McIlwaine. Other similar stations were later established by the Department of Natural Parks and Wildlife at sites on Lake Kyle, in Inyanga and the Matapos (Bell-Cross, 1976).

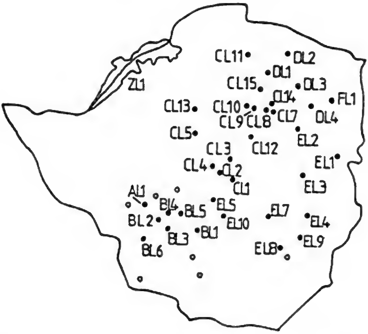
Numerous species of fish were introduced between 1910 and 1960 (listed in Balarin, 1984). These include a large number of fish introduced by angling societies and maintained in private and Government hatcheries. A number of hatcheries are still functional. Some fish species have now become well established in natural waterways creating an important fishery.

Rainbow trout (*Salmo gairdneri*), originally from the UK and trans-shipped via South Africa, was introduced for angling purposes, later to develop into a commercial aquaculture operation. Today, trout are extensively farmed in cages in private dams above the altitude of 1 000 m.

Table 2. SELECTED MORPHOLOGICAL DATA AND USE OF ZIMBABWE RESERVOIRS
(Numbers refer to Figure 2)
(from Thornton, 1980)

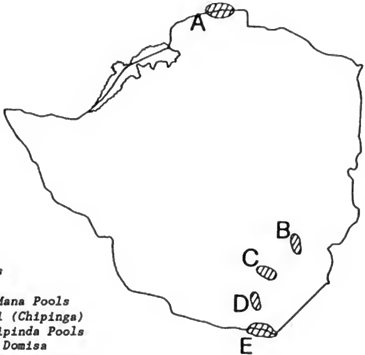
Number	Reservoir	Hydro zone	Year built	Volume (10^6 m^3)	Area (ha)	Maximum depth (m)	Use a/
AL1	Umgusa (Upper)	A	1947	3	77	13	i
BL1	Umzingwane	B	1958	45	456	32	w
2	Ncema (Upper)	B	1973	46	769	32	w
6	Matopos	B	1901	4	67	18	i
CL2	Cactus Poort	C	1944	3	77	16	c
3	Sebakwe	C	1957	155	1 518	32	w,i,r
4	Dutchman's Pool	C	1954	5	283	13	c,i
5	John Mack	C	1973	21	485	18	w
7	Henry Hallam	C	1973	9	215	18	w
8	Prince Edward	C	1929	4	105	8	w
9	McIlwaine	C	1952	250	2 630	27	w,i,r,f
10	Robertson	C	1976	490	8 100	23	w,f
11	Pembi	C	1961	2	61	11	w
12	Ngezi	C	1945	27	580	18	i,r
13	Suri Suri	C	1968	9	213	14	c,i
14	Cleveland	C	1913	1	30	-	w,r
15	Savory	C	1953	1	12	5	i
DL1	Mazoe	D	1920	35	445	31	i
2	Mwenje	D	1969	13	202	20	c,i
3	Eben	D	1968	13	205	20	i
4a	Udu Valley	D	1973	1	15	14	r
4b	Rhodes	D	1972	1	4	10	r
4c	Purdon	D	1971	1	8	13	r
4d	Gulliver	D	1970	1	6	9	r
4e	Mare	D	1955	1	9	7	r
EL1	Alexander	E	1965	7	74	24	w
2	Lesapi	E	1971	68	615	36	i,w
5	Gwenoro	E	1958	32	466	24	w
7	Kyle	E	1961	1 333	9 105	56	i,r,f
8	Bangala	E	1963	130	1 133	41	i
9	McDougall	E	1966	285	2 023	46	i
10	Mushandike	E	1938	38	437	33	i,r
FL1	Connemara (No.3)	F	1961	1	44	9	r
ZL1	Kariba	-	1959	160 368	510 000	119	p,r,f

a/ c=commercial/industrial
f=major fishery (over 100 t/yr)
i=irrigation
p=power generation
r=recreation
w=water supply



Numbers refer
to Table 2

Fig. 2. LOCATIONS OF THE MAJOR DAMS
(Thornton, 1980)



▨ *Floodplains*

A Zambesi River *Mana Pools*
B Sabi River *Sabi (Chipinga)*
C Lundi River *Chipinda Pools*
D Nuanetsi River *Domisa*
E Limpopo River *Sengwe (Pafuri)*

Fig. 3. FLOODPLAINS AND THEIR LOCATIONS IN ZIMBABWE
(after Thornton, 1980)

The present estimate of aquaculture production is 800 t/yr (Van der Lingen, pers.comm.), but this is possibly inclusive of a large number of small commercially operated farm dams. As with the fishery, there would appear to be a paucity of data on the actual extent of fish farming.

Vincke (1989, pers.comm.) detailed aquaculture production in Zimbabwe from 1982 to 1987 as follows:

Table 3. AQUACULTURE PRODUCTION (t) - Zimbabwe, 1982-1987

Species	1982	1983	1984	1985	1986	1987
Oreochromis spp./ *Tilapia* spp.	30	66	46	38	42	46
Salmo gairdneri	-	79	86	93	98	98
Macrobrachium rosenbergii	1	3	6	9	10	12
Total	31	148	138	140	150	156

Recent publicity and local promotion of the development of a freshwater prawn farm at Kariba has spurred a renewed interest in commercial farming. Were the present interest developed to its full potential, over 2 000-2 500 tons of fish could be produced yearly (Balarin, 1982a).

3.2 Fish production and per caput supply

Table 4. FISH PRODUCTION AND PER CAPUT SUPPLY - Zimbabwe, 1970-1987

		Nominal Domestic Production (excluding exports) (t) 2/			Nominal Consumer Supply (exluding imports and exports) (kg/person)		
Year	Population '000 1/	Inland capture	Aqua-culture 3/	Total	Inland capture	Aqua-culture 3/	Total
1970	5 308	2 000 6/	- 4/	2 000	0.4	-	0.4
1971	5 479	2 000	-	2 000	0.4	-	0.4
1972	5 655	2 000	-	2 000	0.3	-	0.3
1973	5 837	2 000	-	2 000	0.3	-	0.3
1974	6 025	2 000	-	2 000	0.3	-	0.3
1975	6 219	2 000	-	2 000	0.3	-	0.3
1976	6 433	2 000	-	2 000	0.3	-	0.3
1977	6 655	9 500	-	9 500	1.4	-	1.4
1978	6 885	11 000	-	11 000	1.6	-	1.6
1979	7 122	9 874	-	9 874	1.4	-	1.4
1980	7 368	13 288	-	13 288	1.8	-	1.8
1981	7 630	16 431	-	16 431	2.1	-	2.1
1982	7 902	17 482	31 5/	17 513	2.2	0.004	2.2
1983	8 184	13 461	148 5/	13 609	1.6	0.02	1.6
1984	8 475	16 271	138 5/	16 409	1.9	0.02	1.9
1985	8 777	17 222	140 5/	17 362	2.0	0.02	2.0
1986	9 099	17 350	150 5/	17 500	1.9	0.02	1.9
1987	9 433	17 344	156 5/	17 500	1.8	0.02	1.8

1/ Source: FAO
2/ Source: FAO Fisheries Department FISHDAB
3/ included in "Inland capture" if not specified
4/ - = data not available
5/ Vincke, 1989 (pers.comm.)
6/ rough estimates from 1970 to 1976

3.3 Inland catch range and potential yield

Table 5. INLAND CATCH RANGE AND POTENTIAL YIELD

Water body	Period	Annual catch range (t) 1/	Potential annual yield (t) 1/
Reservoirs			
Kariba	1980-81	8 737-11 131	8 000-14 000 (30 000)
Kyle	current	180	180
McIlwaine	current	140	300
Robertson	current	400	200-400
Other (large) 2/	-	-	1 160
Other (small) 2/	1980	4 000	4 200-7 200
Rivers/weirs	-	-	5 000
Aquaculture	1987	156	2 000-2 500

No information available for:
Rivers Buzi, Limpopo, Pungoe, Sabi and Middle Zambesi
Reservoirs Amapongokwe, Bangala, Ingwezi, Lesapi, Maitengwe, Manjirenji, Mayfair, Mazoe, Ngesi, Palawan, Ruti, Sebakwe, Siya, Umshandige, and Upper Noema

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1/ Sources: see text
2/ All reservoirs excluding Kariba, Kyle, McIlwaine and Robertson

Total annual yield: 13 613 to 16 007 t (total Table 5);
20 831 t in 1981 (Marshall, 1982; Balarin, 1982b)
15 000 t in 1982 (SADCC, 1984)
(see also Table 4)

Potential annual yield:
26 000 t (Kenmuir, 1982);
19 400 to 28 400 t (Balarin, 1984) plus a further
12 000 t shellfish (Kenmuir, 1980);
22 000 t (SADCC, 1984).

4. STATE OF THE FISHERY (adapted mainly from Balarin, 1984)

4.1 Yield

Apart from the accurate records kept of the Lake Kariba Fishery and those of the lakes where National Parks have a station, there appears to be little or no statistical information of the extent of fishing in other Zimbabwean waters. A recent review by Kenmuir (1982) is perhaps the most up-to-date estimate of the fishery potential.

In essence, the fishery can be divided into Lake Kariba (the main catch) and the rest. Fishing is mainly practised by commercial companies and by subsistence angling and artisanal fishermen. An unknown element of illegal fishing has also to be considered.

4.2 Factors influencing yield

In the Kariba Reservoir, the sardine fishery has remained restricted to the requirement for capital-intensive operations by virtue of the behaviour pattern of fish. Small-scale artisanal fishery development is not considered feasible (Marshall, 1982), although there have been recent attempts at development.

4.3 Future development possibilities

Kenmuir (1980) presents a conservative estimate of fish production potential of all water resources (excluding aquaculture) in Zimbabwe at 26 000 t/yr. If Marshall's (1982) estimates of sardine fishery potential of Lake Kariba and others are included, it can be said that Zimbabwe has an annual potential of from 21 000 to 44 000 tons. A more realistic value, however, may be around 28 200 t/yr. This does not include the shellfish potential of Lake Kariba and Lake McIlwaine, estimated at a further 12 000 t/yr (Kenmuir, 1980).

The fact remains that there is no definite estimate of the actual fishery resources of Zimbabwe's 300 000 ha of fishable waters.

Pond culture is also likely to increase in the future, with a potential development being estimated as 2 000-2 500 t/yr (Balarin, 1982b).

5. KEY BIBLIOGRAPHY

Balarin, 1984

6. WATER BODIES DIRECTORY

Rivers

Buzi
Limpopo
Pungoe
Save/Sabi
Zambesi

Reservoirs

Amapongokwe
Bangala
Ingwezi
Kariba
Kyle
Lesapi
Maitengwe
Manjirenji
Mayfair
Mazoe
McIlwaine
Ngesi
Palawan
Robertson (= Darwendale)
Ruti
Sebakwe
Siya
Umshandige
Upper Noema
Other

BUZI RIVER

(International water)

Geographical data

Source: near Chipinga, Zimbabwe
Altitude: 1 326 m
Total length: 360 km total (35 km in Zimbabwe)
Drainage area: 28 800 km^2 total
(25 600 km^2 in Mozambique; 3 200 km^2 in Zimbabwe)
Countries traversed: Mozambique, Zimbabwe
Major tributaries: Revue, Lucite
Discharges to: Indian Ocean - 19° 52'S; 34° 46'E
Volume of discharge at mouth: 1.45 km^3/yr
Special features: Chicamba Real reservoir on Revue tributary;
floodplain along lower course.

LIMPOPO RIVER

(International water)

Geographical data
Source: Witwatersrand, South Africa
Altitude: 1 732 m
Total length: 1 680 km
Drainage area: 358 000 km^2 total (79 600 km^2 in Mozambique)
Countries traversed: Botswana, Zimbabwe, Mozambique, South Africa
Major tributaries: Elefantes/Olifants, Nuanetsi, Umzingwani, Shashi, Changane
Discharges to: Indian Ocean - 25° 12'S; 33° 31'E
Volume of discharge at mouth: 5.33 km^3 /yr
Special features: numerous dams/reservoirs on tributaries, including Massingir (151 km^2); floodplain along lower course with numerous lakes, including Lakes Gondeza, Pave (2 km^2), Chinanga (5 km^2), Bambene and Linguazi (4 km^2 combined), and Nhangul.

PUNGOE RIVER

(International water)

Geographical data
Source: near Watsomba, Zimbabwe
Altitude: 2 033 m
Total length: 300 km (40 km in Zimbabwe)
Drainage area: 29 500 km^2 total
(28 000 km^2 in Mozambique; 1 500 km^2 in Zimbabwe)
Countries traversed: Mozambique, Zimbabwe
Major tributaries: Urema, Vunduzi, Nhazonia
Discharges to: Indian Ocean - 19° 51'S; 34° 48'E
Volume of discharge at mouth: 3.08 km^3/yr
Special features: floodplains on lower course and on Urema tributary.

SAVE/SABI RIVER

(International water)

Geographical data
Source: Zimbabwe (south of Harare)
Altitude: 1 693 m
Total length: 715 km total (400 km in Zimbabwe; 315 km in Mozambique)
Drainage area: 88 395 km^2 (83 845 km^2 in Zimbabwe; 4 550 km^2 in Mozambique)
Countries traversed: Zimbabwe, Mozambique
Major tributaries: Lundi
Discharges to: Indian Ocean - 20° 58'S; 35° 05'E
Volume of discharge at mouth: 5 km^3/yr
Special features: Several reservoirs within Lundi tributary basin including Kyle, Bangala, Manjirenje and Tokwe Mokorsi.

ZAMBEZI RIVER

(International water)

Geographical data

Source: northwest Zambia and eastern Angola (see Fig. 4)
Altitude: 1 600 m
Total length: 2 574 km
Drainage area: 1 300 000 km^2
Countries traversed Angola, Mozambique, Zambia, Botswana, Namibia, Zimbabwe
Major tributaries: Cuando, Kafue, Luangwa, Shire. The Zambezi system also communicates with the Okovango system via the Chobe River. In Zimbabwe important tributary systems are the Hunyani, Sanyati Gwaai and Mazoe.
Discharges to: Indian Ocean - 18° 47'S; 36° E
Volume of discharge at mouth: 7 070 m^3/sec
Flood regime: December to July, maximum in March
Special features: *In Zambia:* Barotse floodplain (200-9 000 km^2), Kafue flats (200-7 000 km^2), Lukanga swamps (3 000-8 000 km^2), Kariba and Cahora Bassa dams/reservoirs.
In Zimbabwe: the Mana Pools floodplain (circa 1 500 km^2).

Physical and chemical data above Lake Kariba (Coche, 1968)

		Flood	Low water
Temperature: °C		30	17
pH:		-	7.4
Conductivity: K_{20}		50 µS/cm	96 µS/cm
Total alkalinity:		20 mg/l	44 mg/l
Total hardness:		17.9 mg/l	38.1 mg/l
Ionic composition:		mg/l	mg/l
	Na	1.70	3.26
	K	-	0.88
	Ca	4.93	-
	Mg	1.47	3.86
	NO_2-N	0.00376	0.00024
	NO_3-N	0.0047	0.0158
	PO_4-P	0.0295	0.0078

Fisheries data

No. of fish species: Upper Zambezi: 49; Middle Zambezi: 50 (Jubb, 1961)
Total annual catch: in Zimbabwe - no data available

AMAPONGOKWE RESERVOIR

Geographical data

Location: Zimbabwe
Dam height: 28.1 m
Date closed: 1980
Surface area: 5.25 km^2
Depth: 23 m (max); 7.4 m (mean)
Volume: 39 x 10^6 m^3
Catchment area: 177 km^2

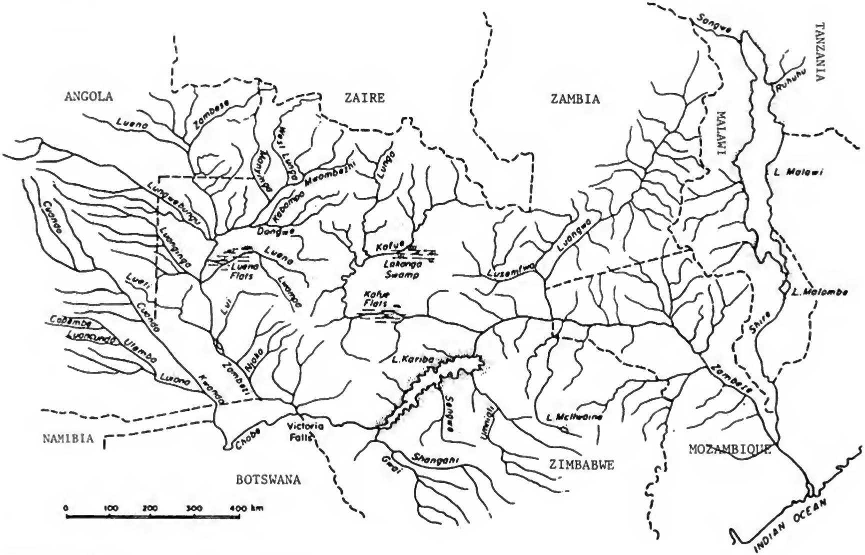

Fig. 4. RIVERS AND LAKES OF THE ZAMBEZI
(Welcomme, 1972)

BANGALA RESERVOIR

Geographical data
Location: Zimbabwe - 20° 41'S; 31° 12'E
Dam height: 50.7 m
Date closed: 1963
Surface area: 11.33 km^2
Depth: 45.1 m (max); 11.5 m (mean)
Volume: 130.02 x 10^6 m^3
Max. length: 11 km
Max. width: 2.5 km
Catchment area: 5 828 km^2
Major inflowing river: Mtilikwe
Outflowing river: Mtilikwe

INGWEZI RESERVOIR

Geographical data
Location: Zimbabwe
Dam height: 39.6 m
Date closed: 1967
Surface area: 8.5 km^2
Depth: 33.5 m (max)
Volume: 69.81 x 10^6 m^3
Catchment area: 847 km^2

KARIBA RESERVOIR

(International water)

Geographical data
Location: Zimbabwe, Zambia (see Figs. 4 and 5)
16° 28'-18° 04'S; 26° 42'-29° 03'E
Date closed: 1958
Altitude: 485 m
Surface area: Zimbabwe 2 952 km^2 (55%)
Zambia 2 412 km^2 (45%)
Total 5 364 km^2
Depth: 120 m (max); 29.2 m (mean)
Volume: 156 km^3
Max. length: 277 km
Max. width: 40 km
Shoreline: 2 164 km
Catchment area: 823 200 km^2
Annual fluctuation in level: 3-4 m
Major inflowing rivers: Zambesi, Umiali
Outflowing river: Zambesi

Physical and chemical data
Surface temperature: 17-32° C.
The lake overturns once a year between March and July.
Monothermy about 22° C.
Dissolved solids: 40-70 mg/l

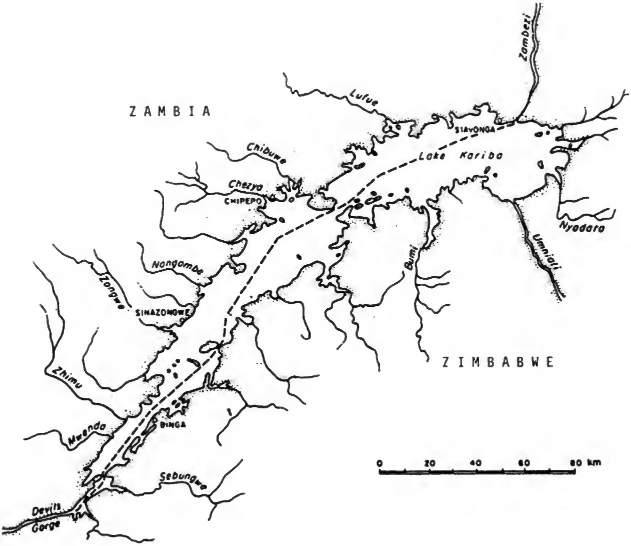

Fig. 5. LAKE KARIBA
(Welcomme, 1972)

KARIBA RESERVOIR (cont.)

Physical and chemical data (cont.)

	(Harding, 1961)	(Coche, 1968 and 1969)	
		Basins I & II	*Basins III & IV*
Conductivity: µS/cm		K_{25} 50-100	K_{20} 88-115
pH:	-	7.5-8.0	7.8-8.9
Ionic composition:	mg/l	mg/l	mg/l
Na	5-8	1.8-3.6	3.2-4.7
K	-	trace-1.8	0.6-1.6
Ca	12.4-14	2-10	7-13
Mg	2.0-3.6	0.5-3	0.5-3
$HCO_3 + CO_3$	62.2-72.0	-	-
Cl	1-3	-	-
SO_4	2.5-3	-	-
NO_2-N	-	0-0.002	0-0.004
NO_3-N	-	0.003-0.04	0.010-0.050
PO_4-P	-	0-0.05	0.01-0.05

Fisheries data

No. of fish species: 46 (Jackson, 1971)

Main catches: *Limnothrissa miodon, Hydrocynus vittatus,* mormyrids, tilapias (Marshall, 1984a; Balarin, 1984) *Limnothrissa miodon* was introduced in 1967-68.

No. of fishermen: in Zimbabwe:
210-280 in 1970, declining to 130 in 1977 (Junor, 1981);
1 000 in 1966, declining to 500 in 1980 (Van der Lingen, 1981a);
37 licensed companies (in 1980), specialized in *L. miodon* fishing (Balarin, 1984).

No. of boats: Commercial fishery using lift nets and night-light fishing, specialized in *L. miodon* fishing: (Balarin, 1984)
1 boat in 1973;
100 boats in 1980, using 174 units of net rigging.

Total annual catch in Zimbabwe:

Year	Total catch (t)	Source
1974	1 632	Balarin, 1984
1975	1 525	Balarin, 1984
1976	1 982	Balarin, 1984
1977	1 738	Balarin, 1984
1978	3 538	Balarin, 1984
1979	5 504	Balarin, 1984
1980	8 737	LKFRI, 1981
1981	11 131	Marshall, 1982

Potential annual yield in Zimbabwe:
Fish: 8 000-14 000 t (Kenmuir, 1981b, 1982)
30 000 t (Marshall, 1982)
Water mussel: 12 000 t (Kenmuir, 1980)

Productivity: 23.2 kg/ha/yr based on MEI relationship (Marshall, 1984c)

Specific references:
Entz, 1984; Kapetsky & Petr, 1984; Marshall, 1984a,b,c

KYLE RESERVOIR

Geographical data
Location: Zimbabwe - 20° 14'S; 31° 02'E
Altitude: 1 035 m
Dam height: 63.1 m
Date closed: 1961
Surface area: 91.05 km^2
Depth: 56.1 m (max); 15.7 m (mean)
Volume: 1.425 km^3
Max. length: 35 km
Max. width: 3 km
Catchment area: 3 989 km^2
Outflowing river: Mtilikwe (Sabi/Lundi basin)

Physical and chemical data
Surface temperature: 16-27° C

Fisheries data
Total annual catch: about 100 t/yr, with a further 80 t/yr from subsistence anglers (Marshall, 1982)
Potential annual yield: 180 t (Balarin, 1984)

LESAPI RESERVOIR

Geographical data
Location: Zimbabwe
Dam height: 41.1 m
Date closed: 1971
Surface area: 6.15 km^2
Depth: 36 m (max); 11 m (mean)
Volume: 67.84 x 10^6 m^3
Catchment area: 673 km^2

MAITENGWE RESERVOIR

Geographical data
Location: Zimbabwe
Date closed: 1965
Surface area: 6.87 km^2
Depth: 3.9 m (max); 1.3 m (mean)
Volume: 9.1 x 10^6 m^3
Catchment area: 686 km^2

MANJIRENJI RESERVOIR

Geographical data
Location: Zimbabwe - 20° 36'S; 31° 36'E
Dam height: 50.3 m
Date closed: 1966
Surface area: 20.23 km^2
Depth: 46.3 m (max); 14.1 m (mean)
Volume: 285.04 x 10^6 m^3
Max. length: 11 km
Max. width: 6.5 km
Catchment area: 1 536 km^2
Major inflowing river: Chiredzi
Outflowing river: Chiredzi

MAYFAIR RESERVOIR

Geographical data
Location: Zimbabwe
Dam height: 38.5 m
Date closed: 1976
Surface area: 12.5 km^2
Depth: 29 m (max); 14.6 m (mean)
Volume: 182 x 10^6 m^3

MAZOE RESERVOIR

Geographical data
Location: Zimbabwe - 17° 32'S; 30° 59'E
Dam height: 34.4 m
Date closed: 1920
Surface area: 4.45 km^2
Depth: 30.5 m (max); 7.9 m (mean)
Volume: 35.12 x 10^6 m^3
Catchment area: 342 km^2

McILWAINE RESERVOIR

Geographical data
Location: Zimbabwe - 17° 54'S; 30° 47'E
Altitude: 1 363.59 m at USL (1 367.86 at high flood level)
Dam height: 36.5 m
Date closed: 1952
Surface area: 26.3 km^2 at USL
Depth: 27.4 m (max); 9.4 m (mean)
Volume: 250 x 10^6 m^3
Max. length: 35.7 km
Max. width: 8 km
Shoreline: 74 km
Catchment area: 2 136 km^2
Annual fluctuation in level: 2-4 m
Major inflowing river: Hunyani
Outflowing river: Hunyani

Physical and chemical data
Surface temperature: 14-25° C
Conductivity: 65-245 μS/cm
pH: 6.3-10.1
Ionic composition:

	mg/l
Na	38-50
K	3-12.5
Ca	2.5-11.6
Mg	1.5-9.2
HCO_3-CO_3	20-60
Cl	13-17
SO_4	1-9
NO_2-N	trace-0.036
NO_3-N	trace-0.68
NO_4-N	trace-2.0

Fisheries data
No. of fish species: 26 (including 5 introductions)

McILWAINE RESERVOIR (cont.)

Fisheries data

Total annual catch:

Year	Tons
1972	105*
1973	140*
1974	106*
1975	115*
1976	87*
1977	-
1978	315**
current	90* plus a further 50 t subsistence angling (Kenmuir, 1981)

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* commercial fishery only

** all fisheries (commercial, subsistence angling and illegal beach seining)

Potential annual yield: 300 t (Marshall, 1982)

NGESI RESERVOIR

Geographical data

Location: Zimbabwe - 18° 42'S; 30° 23'E

Altitude: 20.7 m

Date closed: 1945

Surface area: 5.8 km^2

Depth: 17.7 m (max); 4.6 m (mean)

Volume: 26.8 x 10^6 km^3

Max. length: 5 km

Max. width: 2.5 km

Major inflowing river: Ngesi

Outflowing river: Ngesi

PALAWAN RESERVOIR

Geographical data

Location: Zimbabwe

Dam height: 43 m

Date closed: 1979

Surface area: 5.65 km^2

Depth: 38 m (max); 13.1 m (mean)

Volume: 74 x 10^6 m^3

Catchment area: 1 313 km^2

ROBERTSON (= DARWENDALE) RESERVOIR

Geographical data

Location: Zimbabwe - 17° 50'S; 30° 40'E

Altitude: 1 350 m at USL

Dam height: 27.5 m

Date closed: 1976

Surface area: 81 km^2 at USL

Depth: 22.6 m (max); 6 m (mean)

ROBERTSON RESERVOIR (cont.)

Geographical data (cont.)
Volume: 490×10^6 m^3
Catchment area: 3 792 km^2
Major inflowing river: Hunyani (outflow from McIlwaine Reservoir)
Outflowing river: Hunyani

Physical and chemical data
Surface temperature: 16-24° C

Fisheries data
Total annual catch:
600 t in 1976
400 t current (Balarin, 1984)
Potential annual yield:
200-400 t (Bowmaker, 1975)

RUTI RESERVOIR

Geographical data
Location: Zimbabwe
Dam height: 33.55 m
Date closed: 1976
Surface area: 15 km^2
Depth: 30.55 m (max); 9.3 m (mean)
Volume: 140×10^6 m^3
Catchment area: 2 615 km^2

SEBAKWE RESERVOIR

Geographical data
Location: Zimbabwe - 19° 02'S; 30° 15'E
Dam height: 37.5 m
Date closed: 1957
Surface area: 15.18 km^2 at USL
Depth: 32.3 m (max); 10.2 m (mean)
Volume: 154.57×10^6 m^3
Max. length: 9 km
Max. width: 2 km
Catchment area: 2 538 km^2
Major inflowing river: Sebakwe
Outflowing river: Sebakwe

SIYA RESERVOIR

Geographical data
Location: Zimbabwe
Dam height: 56 m
Date closed: 1977
Surface area: 8.1 km^2
Depth: 47 m (max); 13.1 m (mean)
Volume: 106×10^6 m^3
Catchment area: 518 km^2

UMSHANDIGE RESERVOIR

Geographical data
Location: Zimbabwe - 20° 08'S; 30° 37'E
Dam height: 36 m
Date closed: 1938
Surface area: 4.37 km^2
Depth: 32.9 m (max); 8.8 m (mean)
Volume: 38.26×10^6 m^3
Catchment area: 259 km^2

UPPER NGEMA RESERVOIR

Geographical data
Location: Zimbabwe
Dam height: 35.7 m
Date closed: 1973
Surface area: 7.69 km^2
Depth: 31.7 m (max); 5.9 m (mean)
Volume: 45.46×10^6 m^3
Catchment area: 643 km^2

OTHER RESERVOIRS AND WATERWAYS

Under "Other Reservoirs" are included all reservoirs except the four major reservoirs (Kariba, Kyle, McIlwaine and Robertson). Table 6 gives the available main characteristics.

Table 6. CHARACTERISTICS OF OTHER RESERVOIRS AND WATERWAYS IN ZIMBABWE
(adapted from Balarin, 1984)

Parameter	Other reservoirs		Waterways
	Large >13 ha	Small <13 ha	Rivers/weirs
Surface area ('000 ha)	24 a/	21.0-45.0 a/	20×10^9 m^3 b/
Mean depth (m)	3-4	<3.0	
Number	120 units	8 000 units a/	± 6 390 units d/
Fishery potential ('000 t)	1.16 a/	4.2-7.2 a/	5 a/
Yield potential (kg/ha/yr)	5-50 c/	25 c/ to 300 a/	

a/ Kenmuir, 1981b, 1982
b/ Grizic, 1980
c/ Bowmaker, 1975
d/ Junor, 1981

The 8 000 small reservoirs (less than 13 ha) in Zimbabwe have a total area of 21-45 000 ha (Kenmuir, 1981b). The same study undertook a census of subsistence angling and obtained a value of 300 g/ha. This gave a possible yield of 270-390 kg/ha/yr and a potential harvest of 4 200-7 200 t/yr. Kenmuir (1982) adopted 6 000 t/yr as a theoretical maximum and estimated the 1980 catches at 4 000 t/yr (cited in Balarin, 1984).

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Symbol Country	Symbol Country	Symbol Country
ANG.....Angola	LES.....Lesotho	SEY.....Seychelles
BOT.....Botswana	MAG.....Madagascar	SWA.....Swaziland
BDI.....Burundi	MLW.....Malawi	URT.....Tanzanie
CAF.....Central African Republic	MAR.....Mauritius	UGA.....Uganda
	MOZ.....Mozambique	ZAI.....Zaire
COI.....Comoros	NAM.....Namibia	ZAM.....Zambia
PRC.....Congo	REU.....Reunion	ZIM.....Zimbabwe
KEN.....Kenya	RWA.....Rwanda	

Country
Symbol

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